NICOLET SCIENTIFIC CORPORATION

Serial Number _____

Instruction Manual

for

THE MODEL

440 MINI-UBIQUITOUS®

SPECTRUM ANALYZER

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WAVETEK®

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WARRANTY

All Nicolet Scientific instruments are warranted against defective materials and workmanship for one year. For detailed information on the warranty agreement, refer to the page at the rear of this publication for conditions and shipping instructions.

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INSTRUCTION MANUAL NOTICE

Every effort has been made by the Engineering and Service Departments of Nicolet Scientific Corporation to present accurate, helpful, and readily understood instructions in this manual. Our goal is to assist you in the efficient operation and maintenance of your precision instrument. The following information will facilitate your use of this publication.

CORRECTIONS:

Sometimes, changes in text or descriptions of circuit design changes cannot be incorporated in the printed manual (and its schematic diagrams). In this event, we provide you with the latest data on the colored pages in this manual following this page. These colored pages cover corrections to the text or to certain of the schematic diagrams, and must be read for the manual to properly reflect the equipment you received.

DATA COVERING OPTIONAL FEATURES AND SYSTEM CONFIGURATIONS:

Data covering certain optional features of our equipment, or special system configurations are provided in the text. If you have not ordered these options, the corresponding section of the manual does not apply to the equipment you received.

ADDENDUM

Applicable to the Models 440 below Serial No. XX44061

The following table shows those aspects of the Model 440 units below the serial number XX44061 which are different from the 440 units numbered from XX44061 and above described in the 440 instruction manual.

Serial Numbers Below XX44061	Serial Numbers XX44061 and Above
Front Panel Controls Annotations	
VIEW	
TIME/SPECT/AVER	TIME/INST SPECT/AVER
The Display Controls	
READ - Hz/CPM SCALE AMPLITUDE - LIN/LOG FREQUENCY - LIN/LOG DISPLAY GAIN - X1/X4/X16/(LIN) MAX - 0dB/-10dB/-20dB/(LOG)	FREQUENCY READING - Hz/CPM SCALE - LIN/LOG AMPLITUDE SCALE- LIN/LOG GAIN - X1/X4/X16/(LIN) MAX - 0dB/-10dB/-20dB/(LOG)
DATA (WEIGHTING)	
CONTIN (HANNING) TRANSIENT (FLAT)	CONTIN (WT'D) TRANSIENT (UNWT'D)
FREQUENCY RANGE	
RANGE IN Hz	
10 RANGES from 20 Hz to 20,000 Hz	11 RANGES from 10 Hz to 20,000 Hz
MEMORY PERIOD IN SEC	
10 periods from 20 SEC to .02 SEC	11 periods from 40 SEC to .02 SEC

Serial Numbers Below XX44061	Serial Numbers XX44061 and Above
INPUT SIGNAL	
AC only (No Front Panel Annotation)	AC and DC
STOP/ERASE/RESET/START	
These switches must be released to cause action	Depressing these switches causes action
CURSOR ANNOTATION FREQ/ORDERS	
No Annotation - Reading Inhibited	Annotation in Percent Full Scale
REAR PANEL - J102 PIN CARD EDGE CONNECTORS PINS 36, 37, 38, 39, 41, 42, 43, 45 - 50	
These are spare pins	See Section III, paragraph 3-11E.2 for functions
MANUAL SECTION V, PARAGRAPH 5-8.	
Paragraph 5-8C, Nos. 8 to 10 do not apply Paragraph 5-8C, No. 11 - Code 1101 on DX16 through DX19 indicates that the number of averages equals or exceed "N"	Paragraph 5-8C, Nos. 8 to 11 are applicable

TABLE OF CONTENTS

Paragraph		Page
	SECTION I. INTRODUCTION	
1-1.	Scope of Manual	1-1
1-2.	Organization of Manual	1-1
	SECTION II. SPECIFICATIONS	
	SECTION III. FRONT AND REAR PANEL CONTROLS AND INDICATORS	
3-1.	Scope of This Section	3-1
3-2.	Input Amplitude - The Input Signal Controls	3-1
3-3.	Frequency Range Controls	3-3
3-4.	View and Spectrum Average - The Mode Selectors	3-5
3-5.	The Display Controls	3-9
3-6.	Cathode Ray Tube (CRT) - The Display	3-12
3-7.	The Output Controls	3-18
3-8.	Data (Weighting)	3-19
3-9.	Data Hold/Trig Level	3-20
3-10.	Annotation Switch (Rear Panel)	3-21
3-11.	Rear Panel BNC Connectors	3-22
	SECTION IV. CHECKOUT PROCEDURE USING INTERNAL TEST SIGNAL	
4-1.	Scope of This Section	4-1
4-2.	Initial Settings	4-1
4-3	Graticule Annotation Check	4-1
4-4.	Graticule Check	4-3
4-5.	Cursor Check	4-4
4-6.	Input Amplitude Check	4-6
4-7.	Amplitude and Frequency Scale Check	4-8

Paragraph Page

SECTION IV. CHECKOUT PROCEDURE USING INTERNAL TEST SIGNAL (CONT'D)

4-8. Output Check 4-8
4-9. Data (Weighting) Check 4-9
4-10. Spectrum Average Check 4-9
4-11. View Time Check 4-11

SECTION V.
440 INPUT AND OUTPUT INTERFACE

5-1. Scope of This Section 5-1
5-2. X-Y Plotter Interface 5-1
5-3. External Storage CRT Display Input 5-3
5-4. External Display Source into the 440 5-3
5-5. External Source of Front Panel Commands or Sense 5-3
5-6. External Source of Digital Data into the 440 ... 5-10
5-7. External Source of Digital Data into the 440 Averager 5-13
5-8. External Device to Read Data from the 440 5-16
5-9. External Device Flags 5-19

SECTION VI.
MODEL 440 BLOCK DIAGRAM DESCRIPTION

6-1. Scope of This Section 6-1
6-2. Organization of the 440 6-1
6-3. Basic Block Diagram Description (Figure 6-1) ... 6-1
6-4. Plug-In Board Description and System Block Diagram (Figure 6-2) 6-4
6-5. Mainframe Board Description and System Block Diagram (Figure 6-2) 6-7

Paragraph		Page
	SECTION VII. USER ADJUSTMENTS	
7-1.	Scope of This Section	7-1
7-2.	Input Offset Adjustments	7-1
7-3.	Input Gain Adjustment	7-2
7-4.	A/D Converter Adjustments	7-2
7-5.	Display Adjustments	7-3
7-6.	Power Supply	7-7
	SECTION VIII. OPTIONS	
	SECTION IX. WARRANTY	
	SECTION X. SCHEMATIC DIAGRAMS	

LIST OF ILLUSTRATIONS

Figure		Page
1-1.	Model 440 Mini-Ubiquitous® Spectrum Analyzer	1-0
3-1.	Model 440 Mini-Ubiquitous® Spectrum Analyzer, Front Panel View	3-1
3-2.	CRT Annotation Identification	3-17
4-1.	Initial Settings	4-2
5-1.	440 Output Flow Chart	5-21
6-1.	440 Basic Block Diagram	6-3
6-2.	440 System Block Diagram	6-5
7-1.	Display Board Adjustment Locations	7-4
7-2.	Block Diagram for the Model 440 Power Supply	7-9
7-3.	All Output Voltages Low	7-11
7-4.	AC Main Fuse Blown	7-13
7-5.	Supply Fuse Blown	7-14
7-6.	±15, ±30 Volt Adjustment Location	7-16

LIST OF TABLES

Table		Page
3-1.	Summary of Graticule Displays	3-13
4-1.	Times for Summation Averaging as a Function of Number-N Setting	4-12
5-1.	DX Bus Assignment During DX READ Time	5-5
5-2.	DX Bus Significance for Sense Group 0	5-6
5-3.	DX Bus Significance for Sense Group 1	5-7
5-4.	DX Bus Significance for Sense Group 2	5-8
5-5.	DX Bus Significance for Sense Group 3	5-8
5-6.	Remote Commands and Busses used in Remote Control of Front Panel Commands	5-11
5-7.	XD Bus Assignment for Remote Input Request (XFLG4)	5-15
7-1.	Power Supply Outputs	7-7
7-2.	Voltage Adjustments	7-15

SPECIAL INSTRUCTIONS

SPECIAL INSTRUCTIONS

WARNING

CONCERNING GROUNDING OF ELECTRICAL EQUIPMENT:

1. This equipment is supplied with a detachable, rubber-covered electrical ac power line cord. One termination of the cord is a standard three-contact female connector for mating the AC INPUT receptacle on the instrument's rear panel. The other termination is a 3-prong male connector for mating a power source outlet, with one of the power source terminals at ground potential. THIS EQUIPMENT SHOULD NEVER BE OPERATED UNLESS IT IS PROPERLY GROUNDED.

2. If you use a 2-prong to 3-prong adapter for mating to your power source outlet, make sure that the pigtail lead (the grounding strap which is provided on the 2-prong adapter) is securely grounded. FAILURE TO FOLLOW THIS WARNING MAY RESULT IN ELECTRICAL SHOCK TO OPERATING AND MAINTENANCE PERSONNEL.

3. Nominal 115-volt or 220-volt ac potentials are present on the terminals of the front panel POWER switch and on the rear panel ac POWER INPUT connector and line protective fuse. Nominal 115-volt or 220-volt ac potentials also exist on the terminal strip of the self-contained power supply module and at various electrical terminals within the power supply module. ALWAYS EXERCISE EXTREME CARE WHEN WORKING IN OR NEAR THESE AREAS TO AVOID SEVERE ELECTRICAL SHOCK!

FIGURE 1-1. MODEL 440 MINI-UBIQUITOUS®
SPECTRUM ANALYZER

SECTION I

INTRODUCTION

1-1. Scope of Manual.

This manual covers the description, specifications, and operation, as well as the block diagram description of the MINI-UBIQUITOUS® 440 portable, Real Time Spectrum Analyzer. Also included is a description of the digital interface required to enter data into the system or read data from the system, such as front panel commands to or from a remote source, digital data into the buffer memory, and spectrum data outputted by the analyzer.

The 440 combines the precision of all digital computation of a 400 line spectrum with the usefulness of an internally generated graticule on a built-in display and annotation on the display of all significant front panel settings. See Figure 1-1. The 440 also features 11 frequency analysis ranges, transient capture mode, linear or logarithmic readout of horizontal and vertical axes, a vertical cursor for the readout of any single frequency element and its corresponding spectral value, uniform or Hanning weighting window, up to 512 averages in sum, difference, exponential, or peak mode, display of input time signal stored in the input buffer, and external sampling input.

1-2. Organization of Manual.

A. SECTION II covers the detailed specifications of the instrument.

B. SECTION III describes settings and operation of front and rear panel controls and indicators.

C. SECTION IV includes a checkout procedure using the internal TEST signal.

D. SECTION V describes interfacing the 440 with the following:

1. Plotter
2. External Storage Tube
3. External Display Source
4. External Source of Front Panel Commands or Sense
5. External Source of Digital Data into the 440
6. External Device to Read Data from the 440

E. SECTION VI presents a description of the Model 440 system block diagram.

F. SECTION VII describes the user adjustments of the Model 440.

G. SECTION VIII describes the optional Expansion Plug-in.

H. SECTION IX covers the warranty applicable to the Model 440. Included are instructions for reshipment of the instrument to the factory, if the equipment is damaged in shipment, or malfunctions after receipt by the user.

I. SECTION X includes a set of schematic diagrams for this instrument, and is the concluding section of this manual.

SECTION II

SPECIFICATIONS

2-1. Display (on Built-in CRT)

A. Data

1. Time function, continuous or captured
2. Instantaneous spectrum of time function
3. Averaged power spectrum using exponential or summation averaging.
4. Peak spectrum
5. Difference (subtraction) of spectra
6. Real and imaginary components of instantaneous spectrum
7. Cursor location

B. Electronic Graticule

Rectangular graticule generated on CRT with horizontal and vertical marks: 10 marks for horizontal linear scale; 2 horizontal log (at 1 and 2 decades below full scale); 10 vertical linear; 6 vertical log (10 dB steps).

C. Annotation

Writes letters and numbers indicating the settings of input amplitude (sum of coarse and fine attenuators), frequency range, type of data or averaging mode, averaging number N, data weighting, and display gain; also reads cursor frequency in Hz or CPM and amplitude in dB (amplitude reading is independent of display gain); front panel switch turns off cursor reading.

D. Cursor

Cursor positioned left or right continuously or in single resolution element steps; intensified dot appears where cursor line intersects spectrum or averaged spectrum (frequency and amplitude read on annotated CRT).

E. Harmonic Markers

Additional intensified dots illuminate multiples of cursor setting.

F. Frequency Readout

Readouts can be in Hz (cycles per second), CPM (cycles per minute), percent full scale; frequency range and cursor frequency read accordingly in the annotation.

G. Display Scales

Linear or logarithmic frequency and amplitude scales can be selected.

H. Display Gain

Lin vertical spectrum gains are X1, X4, and X16; log spectrum vertical display can be offset so that the graticule maximum is -10 dB (for display of a 60 dB range from -10 dB to -70 dB with respect to full scale), or -20 dB (60 dB range from -20 to -80 dB); does not affect digital amplitude reading at cursor.

2-2. Analysis Characteristics

A. Frequency Ranges

0-10, 0-20, 0-50, 0-100, 0-200, 0-500, 0-1,000, 0-2,000, 0-5,000, 0-10,000, and 0-20,000 Hz. (No analog or digital output is provided at DC.)

B. Number of Resolution Elements

400 per spectrum (generated from 1024 input time samples).

C. Amplitude Linearity

0.1 or .01% of full scale whichever is greater (no adjustment necessary).

D. Frequency Accuracy

.01 percent of full scale without warmup (no adjustment necessary).

E. Minimum Detectable Signal

-70 dB typical
-75 dB with background subtraction

F. Intermodulation Distortion

-70 dB typical

G. Gain Stability

Spectrum amplitude at cursor location displayed on CRT with typical stability of ±0.1 dB over the temperature range 10° C to 50° C (50° F to 120° F).

H. Expansion Plug-in (Optional)

A built-in translator expands cover from 20 kHz to 100 kHz; or provides finer resolution below 20 kHz. One analyzer band - 50 Hz, 100 kHz, 500 Hz, 1 kHz or 2 kHz can be positioned in 10 Hz steps to 100 kHz. Extra plug-in cards provide other ranges.

2-3. Transient Data

A. Data Hold

Manual HOLD/REL button holds data in input memory or allows new data to enter; AUTO ARM (or remote signal) provides that the next signal with sufficient input level will automatically actuate hold; in auto-hold, 1/8 of memory period before trigger can be viewed; polarity and amplitude of the trigger point selected as ±1/16, ±1/8, ±1/4, or ±1/2 of full input amplitude; lights indicate data being held or unit is armed; spectrum of held data can be fed to averager by pushing START after capture.

B. Viewing Hold Data

Time signal can be viewed on the built-in CRT and plotted; if transient signal captured in automatic hold, trigger level indicated by brightened dot on CRT.

C. Data (Weighting)

CONTIN (WT'D) weighting provided for continuous inputs; TRANSIENT (UNWT'D) weighting provided for transient data.

D. Memory Period

Length of time (sec) of data stored in the input memory is 400/frequency range (Hz).

E. Automatic Transient Averaging

Rear panel connection provides automatic arm, capture, and averaging of a succession of input transients.

2-4. Input Characteristics

A. Input Impedance

100 kilohms

B. Input Coupling

AC (-3 dB at 1 Hz), DC

C. Amplitude Test Signal

rms voltage ranges are 100 mv (0 dB), 316 mv (10 dB), 1 V (20 dB), 3.2 V (30 dB), and 10 V (40 dB); FINE adjustment with 1-dB step vernier from 0 to 10 dB additional attenuation.

D. Input Amplitude Monitor

Lights indicate peak signal levels - OVERLOAD, -6 dB (greater than 1/2 full scale), -12 dB (greater than 1/4 FS), -18 dB (greater than 1/8 FS), and -24 dB (greater than 1/16 FS); all lights below the signal level are illuminated (in overload, all lights are on).

E. Input Sampling Rate

Set at 2.56 times maximum frequency of range selected on internal sampling (FREQ); external sampling input (ORDERS) sets frequency coverage of 1/2.56 of sampling rate (for normalizing spectrum to rotating device to display orders of rotation regardless of speed).

F. Input Filters

Filters are provided on each range with an initial rolloff of 120 dB/octave (7-pole elliptic).

F. Digital Input

External digital data can be loaded in 2's complement form directly into input memory (through rear connector).

2-5. Averaging

A. Averaging Modes

SUM - spectra are added linearly to previous data stored in the average.

DIFF - spectra are subtracted linearly from previous data stored in the average (negative amplitudes clipped at display bottom).

EXPON - average changes in time as the statistics of the spectra change (N = exponential time constant).

PEAK - stores maxima at each frequency location until N spectra have been produced.

B. Averaging Control

STOP - stops averaging manually (also stops plotter in plot mode).

ERASE - erases data from averager memory.

RESET - resets the count N, but does not erase memory contents, so that a new set of spectra can be added to or subtracted from the previous average.

START - starts averaging; adds spectrum of a held transient to the average (also starts plotter in plot mode).

C. Number of Spectra Averaged

N determines time of averaging or time constant of exponential averaging; set from 1 to 512 in binary steps; averaging can be set also to run continuously until STOP button is pushed.

D. IN-PROCESS light

Indicates averaging is taking place.

2-6. Output Characteristics

A. Output Modes

1. CRT - displays all data on the CRT at maximum rate of 25 sweeps per second.

2. STORE CRT (-03 Option) - slows down display of all data (graticule and annotation included) for display on a memory CRT and subsequent hardcopy reproduction.

3. X-Y PLOT - reads out time function, spectrum, or averaged spectrum at a slow rate for standard X-Y plotters; sweep rate varies inversely as the amplitude of the peak; setup position voltages provided by CAL 0-0 (lower left) and CAL FS-FS (upper right); pen lift command provided.

B. Digital Output

16-bit spectrum amplitude with 4-bits additional identification code provided.

C. Remote Control and Sensing (-06 Option)

All front panel switches and amplitude lights can be sensed; all front panel switches except FINE INPUT AMPLITUDE can be remotely controlled.

D. Use of Internal CRT

X and Y (horizontal and vertical) inputs through rear connectors provide display of external data on CRT when normal X and Y signals are disconnected (internal switch).

E. CRT Outputs

X, Y, and Z outputs on the rear panel allow display of any information on an external CRT of sufficient bandwidth (e.g. DO 1300 Large Screen Display).

2-7. Miscellaneous

A. Weight

19 kgm (42 pounds) nominal with typical plug-in.

B. Power

90 to 130 volts or 180 to 260 volts, 50 - 60 Hz, nominal 150 watts.

C. Size

32.6 cm high including feet and handle (12-7/8 inches) 25.3 cm wide (10 inches), 51.9 cm long including maximum front and rear protrusions (20-7/16 inches).

D. Storage Temperature

-55° C to +85° C (-67° F to +85° F)

E. Operating Temperature

0° C to 55° C (+32° F to +130° F)

2-8. Options

-00 Plug-in (blank)
-02 Rackmounting adapter
-03 Store CRT display (slowed display for large screen memory oscilloscope such as DO-613
-06 Remote Control and Sensing of front panel controls
-10 Plug-in Basic (as specified above)
-2 Expansion Plug-in

2-9. Accessories

Model 99F Transit Case
Model DO-1300 Large Screen Display Oscilloscope
Model 24C Spectrum Tracking Adapter (for spectrum signatures)
Model 30B Range Translation Unit (complete with translation oscillator)
Model 51 Transducer Kit
Model 61 Polaroid Camera with hood adapter
Model 66-2A/DO-613 3-D Display of Spectrum Time History
Model 131B X-Y Plotter
Model 131E Automatic X-Y Plotter

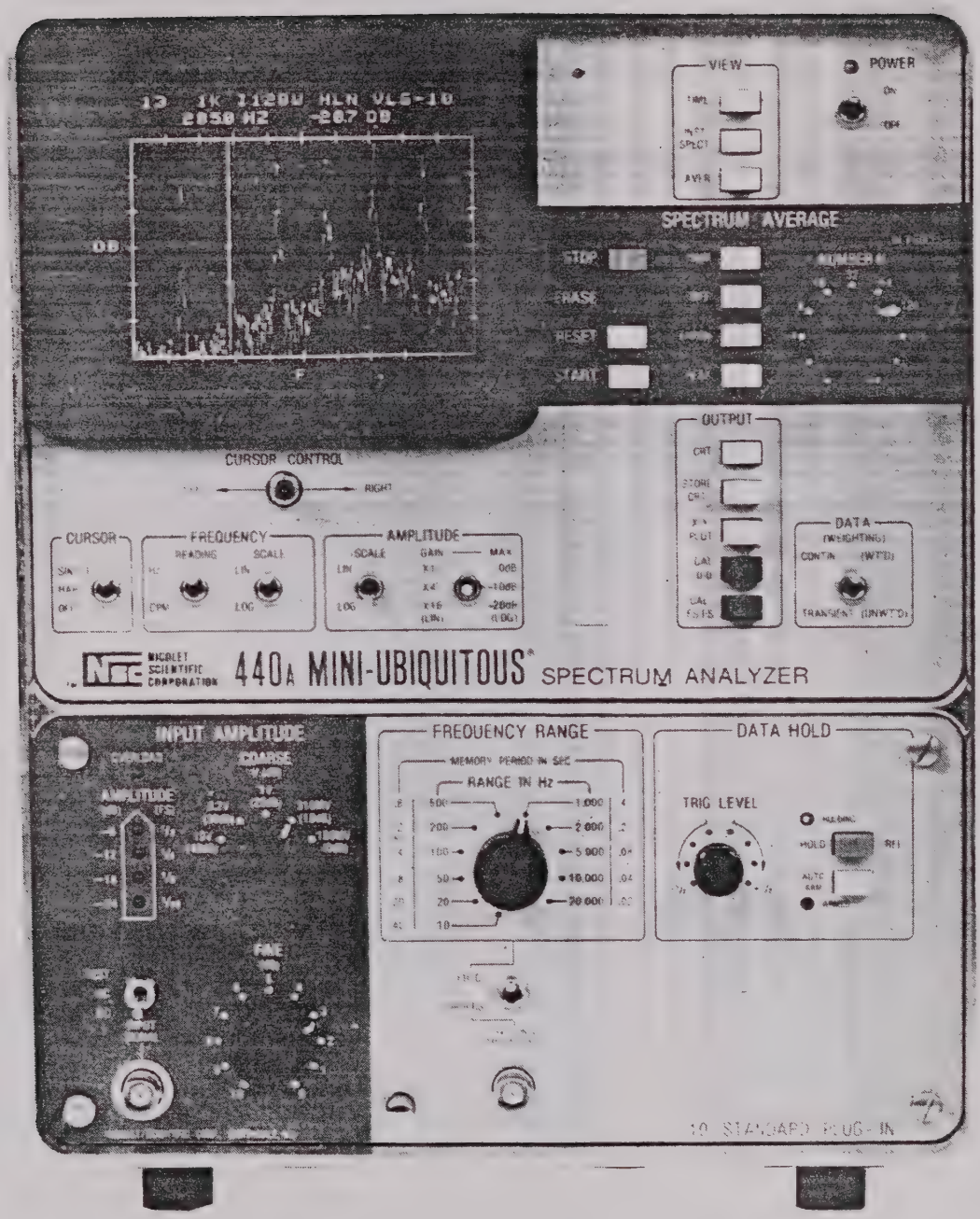


FIGURE 3-1. MODEL 440 MINI-UBIQUITOUS®
SPECTRUM ANALYZER

ERRATA

On page 3-1, paragraph 3-2A should read:

The analog input signal to be analyzed is applied to the BNC connector. The signal is either AC or DC, coupled to the input circuits and should not exceed 28V P-P or 10V rms swing. The DC component of the signal should not exceed ±50 volts. The lower frequency 3 dB point due to AC coupling is 1 Hz.

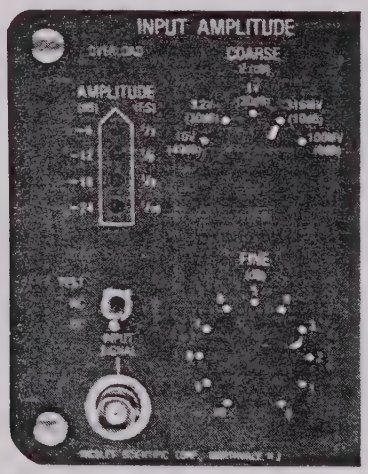
SECTION III

FRONT AND REAR PANEL CONTROLS AND INDICATORS

3-1. Scope of This Section.

This section of the instruction manual will describe the function of each control and indicator on the 440, as well as identify all connectors and corresponding signals that appear on the front and rear panels of the instrument.

3-2. INPUT AMPLITUDE - The Input Signal Controls



A. BNC Connector and TEST/INPUT SIGNAL Switch

The analog input signal to be analyzed is applied to the BNC connector. The signal is either AC or DC, coupled to the input circuits and should not exceed 28V P-P or 10V rms swing. The DC component of the signal should not exceed ±150 volts. The lower frequency 3 dB point due to AC coupling is 1 Hz.

When the TEST/INPUT SIGNAL switch is in the TEST position, an internally generated square wave is coupled into the input circuits. The amplitude of the square wave is approximately

100 millivolts rms, and its frequency is 64% of the selected FREQUENCY RANGE. When this switch is in the AC or DC position, the signal applied to the INPUT SIGNAL BNC connector is fed into the input circuits.

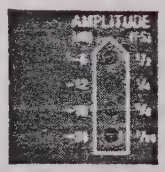
B. COARSE INPUT AMPLITUDE Switch

This five position switch controls the input attenuation over a 100 to 1 (40 dB) range. Each increment of this control changes the attenuation by a factor of 3.16:1 (10 dB), with the 100 MV position designated as 0 dB. The optimum setting of the COARSE INPUT AMPLITUDE switch will generally be determined by the OVERLOAD indicator. If the indicator is on, the input circuits are being over-driven and will generally yield spurious components in the spectrum.

C. FINE INPUT AMPLITUDE Switch

This is an eleven position attenuator switch that provides an additional 0 to 10 dB attenuation of the input signal. The total attenuation is the sum of the dB settings of the COARSE and FINE INPUT AMPLITUDE controls. Each increment of the FINE INPUT AMPLITUDE control represents 1 dB, or a signal ratio of 1.122:1.

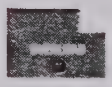
D. AMPLITUDE "LEDs"



This is a group of four LED (light emitting diode) indicators which provide amplitude information on the input signal after the COARSE and FINE INPUT AMPLITUDE controls. Illumination

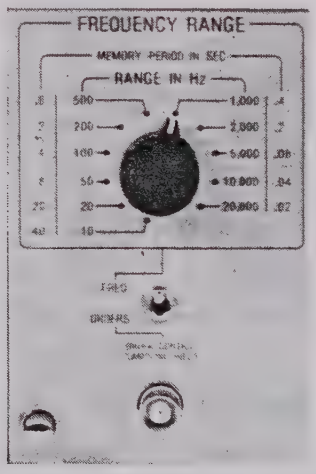
of any indicator signifies that the signal being analyzed is greater than the corresponding level. Thus, when the -18 dB indicator is on and the -12 dB indicator is off, the input signal is between -12 and -18 dB below full scale input. When a particular indicator in this group is on, all indicators below it must also be on.

E. OVERLOAD "LED"

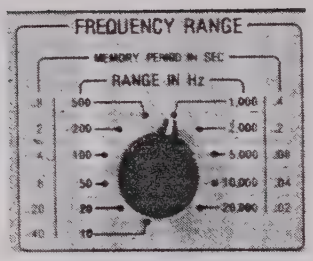


This indicator is on whenever the input signal amplitude causes limiting in the analog-to-digital converter, causing distortion in the output spectrum. When overload is detected, the indicator is held on for a pre-set time so that an overloading condition which occurs at intervals of approximately 0.5 second or less will cause the indicator to remain on continuously.

3-3. FREQUENCY RANGE Controls

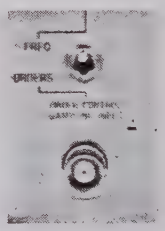


A. FREQUENCY RANGE Control



This control is used to select the cutoff frequency of the input lowpass filter and the internal sampling frequency (equal to 2.56 times the selected range). The switch contains two legends: one is the frequency RANGE IN HZ, and the other is the MEMORY PERIOD IN SEC. The latter reading is valid only when internal sampling is selected, or when the external sampling frequency is 2.56 times the FREQUENCY RANGE. The memory period is always equal to 1024 times the sampling period.

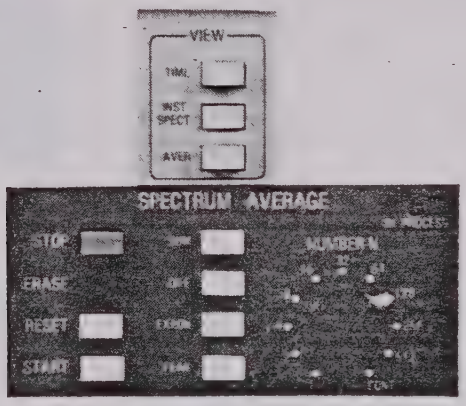
B. FREQ/ORDERS Switch and ORDER CONTROL SAMPLING INPUT Connector



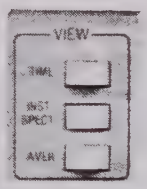
The FREQ/ORDERS is a two position switch. In the FREQ position, sampling is controlled by a crystal oscillator in the 440 and the sampling frequency equals 2.56 times the FREQUENCY RANGE. In the ORDERS position, sampling is determined by an external input, which may be derived from the same mechanical device as the analog input signal to be processed, thereby tracking any frequency fluctuation created by speed variation of the mechanical device.

The ORDER CONTROL SAMPLING INPUT is a BNC connector, to which the external sampling frequency signal is applied. If the signal to be processed is derived from a rotating machine, the sampling input frequency may be the fundamental or any order of this fundamental.

3-4. VIEW and SPECTRUM AVERAGE - The Mode Selectors



A. VIEW -
TIME/INST SPECT/AVER



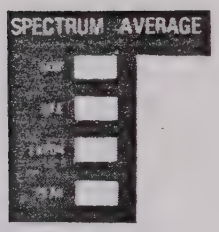
This group of three interlocked switches operates as follows:

1. TIME - When this button is depressed, the display consists of the time data stored in the input buffer memory from which the spectrum is derived. This data is always displayed with both linear vertical and horizontal scales.

2. INST SPECT - This switch position selects the display of the instantaneous spectrum data from the processed input data block. As the input data is updated via new samples, the spectrum derived is correspondingly updated. When the 440 is in HOLD, (see paragraph 3-9A), the INST SPECT display will exhibit no variation since it is derived from a fixed block of stored input data. The INST SPECT display can be presented on either linear or logarithmic vertical or horizontal axis.

3. AVER - In the AVER position, the display represents the averaging of successive, 50% redundant spectra in each of the 400 averager memory locations. Averaging is performed by calculation of the square of each spectral point prior to averaging. Upon completion of averaging, the square root of each averaged spectral point is displayed. The AVER data may be displayed in linear or logarithmic vertical and horizontal scales.

B. SPECTRUM AVERAGE - SUM/DIFF/EXPON/PEAK



This group consists of four interlocked pushbutton switches. Each of the four settings determines a unique processing mode in the averager. NOTE: A significant increase in the averaging speed can be obtained by turning both the CURSOR switch and the rear panel ANNOTATION switch to the OFF position.

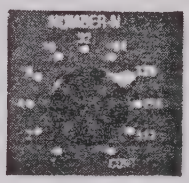
1. SUM - Successive 50 percent redundant spectra are normally added and stored in the averager memory on a cell-by-cell basis. A 50 percent redundant spectrum is defined as one obtained from a set of 1024 input time data points, 512 of which were used to derive the previously averaged spectrum. In the SUM averaging mode, averaging will continue until N spectra have been accumulated, where N is determined by the setting of the NUMBER-N switch.

2. DIFF - In this mode of averaging, successively averaged spectra are subtracted from whatever values have been stored in the averager memory prior to the start of this mode. If the result of subtraction is negative, the value stored in the averager memory is zero, rather than the negative difference. This mode is useful in minimizing the effect of background noise on a signal spectrum.

3. EXPON - This is a weighted summation mode, where recent non-redundant spectra are more heavily weighted than older spectra. The weighting window is exponential with a constant equal to the setting of the NUMBER-N switch. For example, if the NUMBER-N switch is set to 128, then the 128th averaged spectrum before the currently averaged one is weighted by approximately .37 of its original value. Alternatively, the constant N indicates the number of averages required to bring the averaged value to 63% of its final value. The actual time constant corresponding to the N constant is determined by the time between non-redundant spectra.

4. PEAK - In this mode, each spectral value is examined and those spectral values that exceed values previously stored in corresponding locations are replaced. Thus, each location in the averager memory contains the largest value of the spectral point that occurred during the N spectra observed. The examination of each of the 400 new spectral values and the decision to store new peak values occurs at the same rate as SUM averaging.

C. NUMBER-N
1/2/4/8/16/32/128/256/512/CONT



This switch selects the number of spectra averaged in the SUM, DIFF, or PEAK modes. The averaging process is automatically terminated and the output normalized when the pre-set number of spectra have been processed. When the CONT setting has been selected, the processing continues and the output is normalized as if 1024 were selected. In the EXPON mode, this switch sets the RC time constant. After the selected number of spectra have been averaged, the average value is 63% of its final value.

D. IN PROCESS

This LED indicator warns that an averaging cycle is in process. During the averaging cycle, this indicator flashes although the rate of flashing is <u>not</u> related to the averaging rate. However, there are exceptions in the following settings:

NUMBER-N/CONT - In this position, in all averaging modes, the IN PROCESS LED will continue to flash, even after the first 1024 spectra have been analyzed. Depressing the STOP pushbutton will stop averaging in this position.

EXPON - After reaching the N constant selected by the NUMBER-N switch (except in the NUMBER-N/CONT position), the IN PROCESS indicator will remain illuminated, and averaging continues until the STOP pushbutton is depressed.

This indicator is normally off prior to initiating an averaging process and after completing the cycle.

E. START/RESET/ERASE/STOP

This is a group of momentary pushbutton switches whose action depends on the settings of the SPECTRUM AVERAGE and the OUTPUT switch groups. This section will describe the application of these switches to the averaging mode and the system application of the RESET button. Refer also to paragraphs 3-7A, B, and C for other functions, with regard to the OUTPUT controls.

1. START - This is a momentary action pushbutton switch which starts the averaging process.

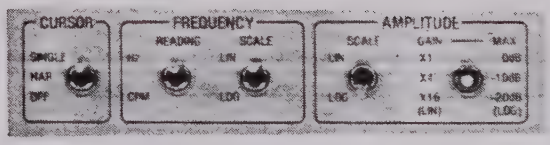
2. RESET - This momentary pushbutton switch will stop the averaging cycle and initialize the elapsed number of measurements count to zero. Activation of START, following RESET, will then cause the full number of measurements to take place, as set on the front panel NUMBER-N switch.

Beyond this application, RESET serves an important system function. Whenever power is applied to the 440, or should a momentary power transient place the 440 in an inoperative condition (e.g., incorrect or no display), activation of the RESET button will reinitialize the entire system and restore normal operation.

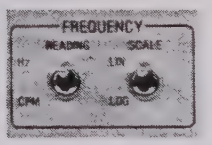
3. ERASE - This momentary pushbutton switch will erase, or write zero data into every memory location in the averager. This button is active regardless of any other front panel switch setting.

4. STOP - The STOP switch will cause the averaging to halt. If START is activated following STOP activation, the process resumes from the point where it halted.

3-5. The Display Controls



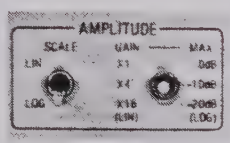
A. FREQUENCY READING/SCALE



1. READING-Hz/CPM - This switch is used to obtain a cursor frequency readout in either Hz (Hertz) or CPM (cycles per minute), the latter being equal to 60 times the value in Hz. The second annotation field, used to indicate the setting of the FREQUENCY RANGE switch will always read in Hz regardless of the setting of the READING-Hz/CPM switch.

2. SCALE-LIN/LOG - This switch is effective when viewing either SPECT or AVER data. In the LIN position, the horizontal axis represents equal spacings of 400 readout addresses. In the LOG position, the horizontal axis is scaled so that equal increments along this axis represent equal address ratios (e.g., the spacing between the 5th and 10th address will be the same as the spacing between the 10th and 20th address, as well as between the 200th and 400th address). When viewing TIME data, the horizontal axis will always be linear; however, the LOG position of this switch will be indicated in the annotation portion of the display by the letters HLG.

B. AMPLITUDE SCALE/GAIN/MAX



1. SCALE-LIN/LOG - This switch is active when viewing SPECT or AVER waveforms.

In the LIN position, the graticule is divided into ten vertical divisions with 0 linear amplitude coinciding with the bottom graticule line, and 1 linear amplitude (or 100%) coinciding with the top graticule line. Note that the linear amplitude scale corresponds to spectrum voltage when viewing instantaneous SPECT, and to the square root of the averaged power spectrum when viewing AVER spectrum. When using the LIN amplitude scale, in conjunction with spectrum display, the DISPLAY GAIN switch can be used to provide linear gains of X1, X4, and X16.

In the LOG position, the vertical scale is divided into six divisions, each division representing 10 dB. The definition of 10 dB is a voltage ratio of 3.16:1, or a power ratio of 10:1. The six divisions, therefore, provide a viewing range of 60 dB, or 1000:1 voltage ratio, or one million-to-one power ratio. When the AMPLITUDE SCALE switch is in the LOG position, the DISPLAY MAX switch can be used to provide offsets of 0, -10, or -20 dB. The LOG AMPLITUDE SCALE setting is inoperative in the VIEW TIME switch setting. When viewing time data, the vertical axis will always be linear; however, the LOG position of the switch will be indicated in the annotation portion of the display by the letters VLG.

2. GAIN/MAX - This switch provides three gain or offset positions as follows:

GAIN-X1/X4/X16 - When the vertical, or amplitude scale is linear, the top graticule line represents a full scale, 1/4th full scale, or 1/16th full scale value, respectively, for the three switch positions. Data larger than display maximum values appear as limited values at the top of the display.

MAX-0 dB/-10 dB/-20 dB - When the vertical, or amplitude scale is LOG, these values represent the value of a signal that appears at the top line of the graticule for each of the three switch positions. The corresponding value at the bottom graticule line is -60 dB, -70 dB, or -80 dB. The amplitude readout of the cursor on the CRT will be in dB (relative to actual full scale) regardless of the DISPLAY GAIN/MAX switch setting, provided that the signal on which the cursor is placed is not limited at the top or bottom of the display. In those instances, the cursor readout will indicate the value represented by an unlimited signal which would appear at the top or bottom graticule line, respectively.

For example: The MAX setting is at -10 dB. The top and bottom graticule lines now represent -10 dB and -70 dB, respectively. Assume that the cursor is placed on a data point whose value is -6 dB. Since this value is larger than the full scale value of -10 dB, the readout will appear as -10 dB. If the cursor is now placed on a data point whose value is -75 dB, the readout will appear as -70 dB. Note that cursor readings of amplitude are accurate to within 0.1 dB.

C. CURSOR
SINGLE/HAR/OFF

This three position switch controls the display of a vertical cursor line on the CRT and the associated readout of amplitude and frequency.

1. SINGLE - In this position, a vertical line is generated from the top of the graticule to the bottom of the graticule at a frequency determined by the CURSOR CONTROL. The intersection of this cursor with the spectrum display will be intensified and the dB value relative to 0 dB (including setting of the DISPLAY GAIN) will read out on the CRT. The horizontal coordinate of the cursor will be read out in Hz, CPM, or percent full scale according to the setting of the READ, FREQUENCY RANGE, and FREQ/ORDERS switches.

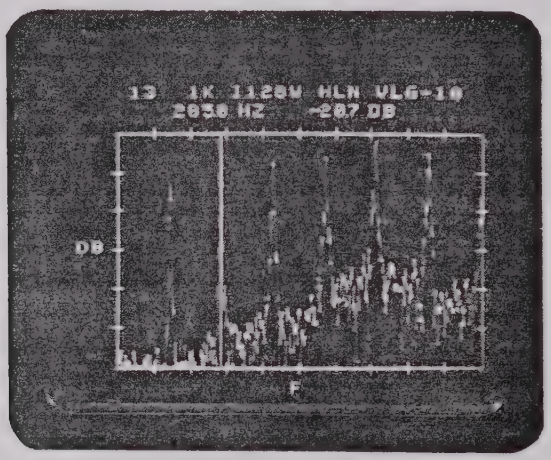
2. HAR - In this position, the cursor is generated as above; in addition, at frequency addresses that are multiples of the cursor frequency address, the displayed spectrum point will be intensified. At the second harmonic address, two points (harmonic address plus address immediately following) are intensified. At the third harmonic address, three points are intensified; at the fourth harmonic address, four points are intensified; at the fifth harmonic address, and above, five points are intensified. The increasing number of addresses intensified are required to identify harmonics of a signal frequency, since any slight offset of the fundamental from the center of the frequency analysis cell will result in a shift of a number of cells at higher harmonics.

3. OFF - In this position, the vertical cursor line, as well as the displayed values of amplitude and frequency, are turned off.

D. CURSOR CONTROL

This is a "center: off position; LEFT or RIGHT: momentary action" type switch. The LEFT position controls cursor motion to the left; the RIGHT position controls cursor motion to the right. The cursor will "single step" when the switch is activated in the RIGHT or LEFT positions for less than approximately two seconds. If held in either position for longer than two seconds, the cursor will slew at a rate of approximately 16 seconds for the display span.

3-6. Cathode Ray Tube (CRT) - The Display



The CRT display consists of the following components:

A. Graticule - The graticule consists of a rectangle which encloses the spectrum or time display. The horizontal and vertical line of the rectangle are divided into equal intervals by means of short "ticks", or lines perpendicular to the axis. The number of ticks in each direction is a function of the VIEW selection and the SCALE selections.

When viewing the vertical axis on a logarithmic scale, the letters "DB" will appear to the left of the rectangle. When viewing the horizontal axis on a linear or logarithmic frequency, or a time scale, the letter "F" or "T" will appear at the bottom of the rectangle. A summary of graticule displays for the different switch settings is presented in Table 3-1.

TABLE 3-1. SUMMARY OF GRATICULE DISPLAYS

SWITCH POSITIONS			VERTICAL AXIS			HORIZONTAL AXIS		
View	Scale		Annotation	Identification on Axis	Number of "Ticks"	Annotation	Identification on Axis	Number of "Ticks"
	Amplitude	Frequency						
TIME	NA	NA	NA	None	9	NA	T	11
SPECT	LIN	LIN	VLN	None	9	HLN	F	9
SPECT	LIN	LOG	VLN	None	9	HLG	F	2
SPECT	LOG	LIN	VLG	DB	5	HLN	F	9
SPECT	LOG	LOG	VLG	DB	5	HLG	F	2
AVER	LIN	LIN	VLN	None	9	HLN	F	9
AVER	LIN	LOG	VLN	None	9	HLG	F	2
AVER	LOG	LIN	VLG	DB	5	HLN	F	9
AVER	LOG	LOG	VLG	DB	5	HLG	F	2

The graticule will not be displayed if the slide switch on the rear panel is in the OFF position.

The following is a summation of the display representation for the settings previously discussed.

1. TIME - (including Vertical Linear and Horizontal Linear)

Vertical Linear is divided into ten divisions, each division representing ±20% of full scale. The center of the vertical scale represents zero; the top graticule line equals +100% full scale; the bottom graticule equals -100% full scale. The AMPLITUDE GAIN/MAX and SCALE/LOG switches are inoperative in this mode. When not in HOLD, the COARSE and FINE INPUT AMPLITUDE controls will change the amplitude display of the TIME waveform in direct proportion to the switch settings.

Horizontal Linear is divided into twelve equal divisions, each division representing 100 addresses in the input buffer memory. Inasmuch as the input buffer memory contains 1024 data words, the display of TIME data will terminate approximately 1/4 division past the 10th "tick" on the horizontal axis. The FREQUENCY SCALE LOG switch is inoperative in this mode.

When TIME is displayed, the 128th data point from the origin is intensified. This point represents the threshold crossing amplitude in the ARM operation of the DATA HOLD mode. (See paragraph 3-9A.3.)

2. INST SPECT - (including Vertical Linear, Vertical Log, Horizontal Linear, and Horizontal Log)

Vertical Linear is divided into 10 equal divisions, with the bottom equaling zero and the top equaling full scale (or 100%). The linear scale represents voltage.

Vertical Log is divided into 6 equal divisions of 10 dB (1 to 10 power ratio) per division with the top of the graticule equal to 0 dB, or unity power ratio, and the bottom of the graticule equal to -60 dB (or 1 to one million power ratio).

Horizontal Linear is divided into 10 equal divisions along the horizontal axis, each division representing 40 spectral addresses.

Horizontal Log is divided into 3 equal divisions, with successive divisions in the ratio of 10 to 1. The two horizontal "ticks" represent the 4th and 40th spectral addresses, respectively, with the origin representing the first address and the right end of the graticule representing the 400th address.

3. AVER - In this setting, the scaling of horizontal and vertical axes is identical to that available in the VIEW/INST SPECT mode. The linear vertical scale used when viewing averaged data represents the square root of the averaged power spectrum, rather than an averaged voltage spectrum.

B. Annotation - A summary of all significant front panel control settings is presented along the topmost line of the display. Annotation will appear on the CRT if the three position rear panel slide switch is in the FULL position.

The significance of each field in the line of annotation is as follows: (Refer to Figure 3-2.)

Field 1 (leftmost field) - 2 digits from 0 to 50 representing the sum of the dB settings of the COARSE and FINE INPUT AMPLITUDE controls.

Field 2 - Up to 3 alph-numeric positions representing the setting of the FREQUENCY RANGE control. The CRT readings are in Hz and appear as 10 to 500 and 1K to 20K, according to the control setting.

Field 3 - A letter representing the settings of the VIEW selector and the SPECTRUM AVERAGE selector.

T = VIEW TIME button depressed

I = VIEW SPECTRUM button depressed

S = VIEW AVERAGE button and SPECTRUM AVERAGE SUM button depressed

D = VIEW AVERAGE button and SPECTRUM AVERAGE DIFF button depressed

X = VIEW AVERAGE button and SPECTRUM AVERAGE EXPON button depressed

P = VIEW AVERAGE button and SPECTRUM AVERAGE PEAK button depressed

Field 4 - Up to 3 alpha-numeric positions corresponding to the setting of the SPECTRUM AVERAGE NUMBER-N control from 1 to 512. In the CONT position of this control, the letters CON are displayed in this field.

Field 5 - One of two letters representing the setting of the DATA (WEIGHTING) selector.

W = DATA switch in the CONTIN (WT'D) position

U = DATA switch in the TRANSIENT (UNWT'D) position

Field 6 - 3 letters representing the setting of the FREQUENCY SCALE selector.

HLN = FREQUENCY SCALE switch in LIN position

HLG = FREQUENCY SCALE switch in LOG position

Field 7 - 3 letters representing the setting of the AMPLITUDE SCALE selector.

VLN = AMPLITUDE SCALE switch in the LIN position

VLG = AMPLITUDE SCALE switch in the LOG position

Field 8 - Up to 3 alpha-numeric positions representing the setting of the DISPLAY - GAIN/MAX selector as a function of the AMPLITUDE SCALE selector.

X1 = LIN AMPLITUDE SCALE and DISPLAY GAIN set to X1

X4 = LIN AMPLITUDE SCALE and DISPLAY GAIN set to X4

X16 = LIN AMPLITUDE SCALE and DISPLAY GAIN set to X16

-0 = LOG AMPLITUDE SCALE and DISPLAY MAX set to 0 dB

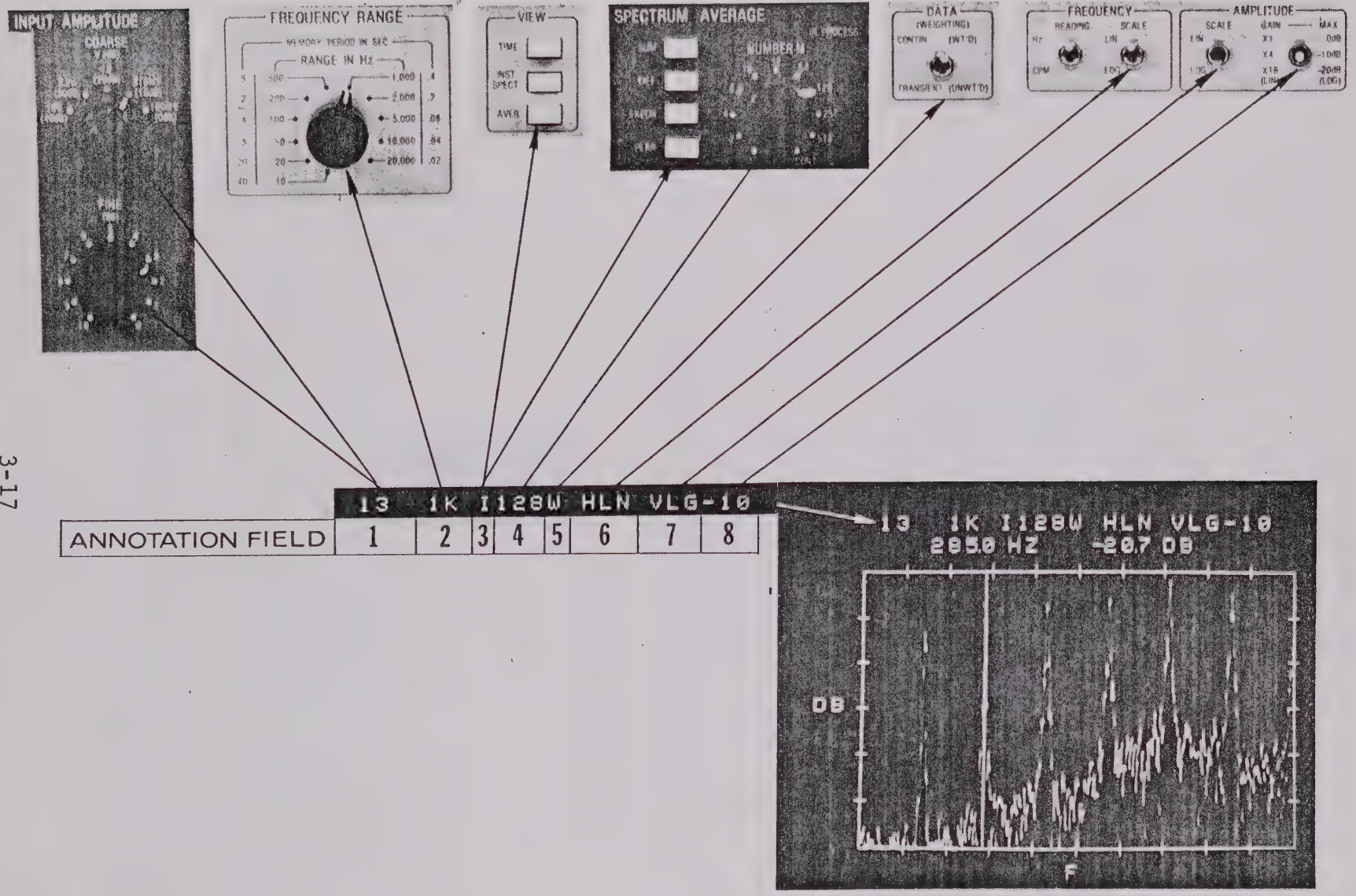


FIGURE 3-2. CRT ANNOTATION IDENTIFICATION

-10 = LOG AMPLITUDE SCALE and DISPLAY MAX set to -10 dB

-20 = LOG AMPLITUDE SCALE and DISPLAY MAX set to -20 dB

C. Cursor - The cursor display consists of a vertical line from top to bottom of the graticule at a horizontal coordinate determined by the CURSOR CONTROL. The amplitude and frequency at the intersection of the cursor and the spectrum is displayed in two fields of special annotation directly above the graticule. The left field is the frequency readout of the cursor location in either Hz, CPM, or percent full scale, depending on setting of READING-Hz/CPM and the FREQ/ORDERS selectors. The right field is a readout in dB of the amplitude of the signal below full scale. This readout automatically accounts for the DISPLAY-GAIN/MAX setting but will read the amplitude at the graticule for limited values.

When TIME data is displayed, both the cursor line, as well as amplitude and frequency readout displays, are inhibited.

Aside from this special case, the display of cursor, as well as the intensification of the point where the signal and cursor line intersect, and intensification of harmonics of this point, are controlled by the CURSOR switch.

3-7. The OUTPUT Controls

This group consists of five interlocked pushbutton switches and is employed to select various optional output displays. Selection of any of the five positions will not normally provide the selected output until the START pushbutton has been depressed except the CAL 0-0 and CAL FS-FS.

A. CRT - This position provides the normal internal display as well as an output for remote CRT display. The START button (paragraph 3-4E) must be depressed to begin an averaging display on the CRT.

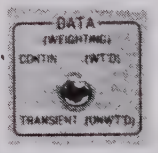
B. STORE CRT - This position provides a single slow readout of the entire display to a storage oscilloscope such as the Tektronix 611 or 613. Depressing the START pushbutton will provide a single slow scan sweep (approximately 1/2 second) with Z-axis gate (J11, rear panel). Upon completion of a single sweep, the display will automatically return to normal CRT display until the START pushbutton is depressed.

C. X-Y PLOT - This position provides a single slow readout of the entire display to an X-Y recorder. The pen outputs (on the rear panel) are normally clamped near zero/zero until the START pushbutton is depressed. This will initiate a pen lift signal and start a slow scan with slew rate limiting. A single sweep is generated and the pen outputs remain at the last point until the RESET pushbutton is depressed which will automatically return the display to the normal CRT display. The plot output may be stopped during the sweep by depressing the STOP pushbutton. After stopping in the middle of a plot output, the sweep may be restarted from the last point, or reset, by depressing the START or RESET pushbuttons, repectively.

D. CAL 0-0 - This position provides a single point output at the origin for calibrating an X-Y recorder.

E. CAL FS-FS - This position provides a single point output at full scale for both vertical and horizontal axis, for calibrating on the X-Y recorder.

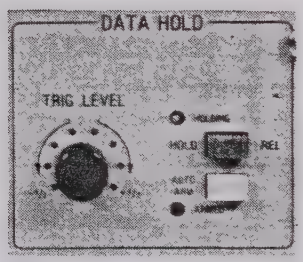
3-8. DATA (WEIGHTING)



A. CONTIN (WT'D) - In the CONTIN position of this switch, the input data block is weighted, or multiplied, by the function $\sin^2 n/1024$, where "n" represents the position of the sample in the 1024 data block. This weighting function is also referred to as Hanning weighting and provides for a sharper rolloff of the signal in the frequency domain due to the finite length of the input signal, than that provided by uniform weighting.

B. TRANSIENT (UNWT'D) - This position of the switch leaves the input data block unweighted (or uniformly weighted) and provides a slow rolloff of the effect of any single point in the frequency domain due to the finite length of input signal processed.

3-9. DATA HOLD/TRIG LEVEL



A. DATA HOLD

1. HOLD/REL - This momentary pushbutton switch provides alternate action to inhibit or allow collection of input data samples in the input buffer memory. There are no sample delays or threshold levels involved in the HOLD/REL operation, as with the AUTO ARM. Consequently, if the 440 is in the ARMED state and the HOLD/REL button is pressed, the system will go into HOLD immediately and the previous 1024 samples are "frozen" in the input buffer memory. Pressing the HOLD/REL button a second time places the system in its released mode immediately.

2. HOLDING - This indicator is on whenever the system has been placed in a HOLD state due to transient capture or manual HOLD action.

3. AUTO ARM - This momentary pushbutton switch arms the threshold detection circuits to recognize the point at which the input signal crosses the trigger level setting. When this point is detected, 896 additional samples are collected.

Further collection of data samples is halted at this point. The threshold point is therefore represented by the 128th sample stored in the input buffer memory, which always holds the most recent 1024 samples collected.

4. ARMED - This indicator is on from the time that the AUTO ARM is activated until the TRIG LEVEL is exceeded, or until the HOLD/REL momentary action button is pressed.

B. TRIG LEVEL

This is an eight position switch used to control the threshold level of an input signal to be detected when capturing a transient. This switch is effective only when the AUTO ARM button is pressed. The maximum counter-clockwise position is set for -1/2, i.e., when the signal threshold is equal to or less than (algebraically) -1/2 full scale, the trigger level will have been exceeded. The next three-positions are -1/4, -1/8, and -1/16, respectively. The following four positions are +1/16, +1/8, +1/4, and +1/2. The full scale reference for the TRIG LEVEL setting is 100 MV after attenuation by the COARSE and FINE INPUT AMPLITUDE controls.

3-10. ANNOTATION Switch (Rear Panel) FULL/GRAT/OFF

This is a three position slide switch that is used to control the display of graticule and cursor, as follows:

A. FULL - The full graticule and annotation sections are included in the display.

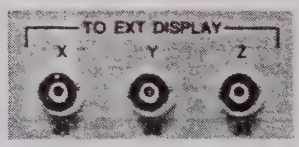
B. GRAT - The graticule is included in the display; however, the annotation portion is omitted.

C. OFF - Neither graticule nor annotation portions are displayed. Note, however, that the cursor coordinate readout which appears normally on the line below annotation is not controlled by this switch.

The principal advantage in inhibiting the display of either graticule or cursor is the increased speed of averaging. With the ANNOTATION switch in the OFF position, as well as the CURSOR switch in the OFF position, an improvement in averaging speed of approximately two to one can be obtained on the higher frequency ranges.

The graticule display should normally be inhibited when outputting the 440 display information to a CRT (cathode ray tube) with an internal graticule.

3-11. Rear Panel BNC Connectors



A. TO EXT DISPLAY
X, Y, Z BNC Outputs

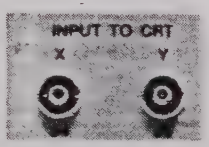
The outputs at these BNC connectors match the corresponding signals to the internal CRT and have the following nominal voltage levels:

1. J1 - X - Horizontal Output. 0 to +1 volt, analog. +1 volt corresponds to right of screen.

2. J2 - Y - Vertical Output. 0 to +1 volt, analog. +1 volt corresponds to top of screen.

3. J3 - Z - Z-axis (intensity axis) Output. 0 to -2 volts, digital. 0 volts or greater turn on beam; (-2 volts or less turn off beam).

B. INPUT TO CRT
X, Y BNC Inputs



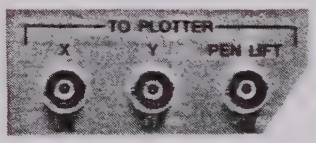
These inputs are used to display an external signal on the 440 internal CRT when the INT/EXT slide switch (S1) on the Display Board is in the EXT position, and the Z axis switch (ON/OFF) is in the OFF position. The inputs required are as follows:

1. J4 - X - Horizontal Input. 0 to +4 volts, analog. +4 volts corresponds to right of screen.

2. J5 - Y - Vertical Input. 0 to +4 volts, analog. +4 volts corresponds to top of screen.

Note that the buffered X and Y input signals to the CRT will appear at the X and Y output BNC connectors with the same voltage levels when the INT/EXT switch (S1) on the Display Board is in the EXT position.

C. TO PLOTTER
X, Y, PENLIFT
BNC Output



These connectors are used in the plotting mode and provide the X and Y analog output signals to the plotter, as well as a Pen Lift signal used to activate the pen when plotting. The signals are defined as follows:

1. J6 - X - Horizontal Output. This signal is nominally at .7 volts when not plotting and goes from +.7 to +3.95 volts while plotting.

2. J7 - Y - Vertical Output. This signal is nominally at .33 volts when not plotting and goes from +.33 to +3.42 volts.

3. J8 - PEN LIFT. This is a relay contact closure during plotting. Contacts are open at all other times.

D. AVG TRG OUT/
ARM TRG IN/
613 Z AXIS
BNC Connectors

1. J9 - AVG TRIG OUT - This is a digital signal indicating that the 440 input buffer memory has been read out and is available for loading new data. The signal is normally in the high state (+2.5 to +5.0 volts) and goes low (0 to +.7 volts) for 1/2 microsecond when the input buffer readout is complete.

2. J10 - ARM TRG IN - A digital input pulse at this connector will arm the circuits in the -10 Plug-In unit to accept an input signal above the threshold level established by the TRIG LEVEL front panel control which will place the 440 into HOLD after the following 896 samples. The pulse is a normally high level and goes low for at least 1 microsecond. It is the low to high (trailing edge) transition that will cause the arm operation. The pulse duplicates the effect of the AUTO ARM switch.

3. J11 - 613/611 Z AXIS - This is a logic output signal that is active during the readout of the spectrum into the 613/611 storage oscilloscope. The level is normally low and will go high during the 613/611 readout whenever a display point is to be written onto the 613/611 cathode ray tube.

E. J101 and J102 Pin Card Edge Connectors

1. J101 - 50 pin card edge connector with pin assignments as follows:

Pin	Mnemonic	Explanation
1	XDS0	External, bus multiplexer select code, bit 0
2	XDS1	External, bus multiplexer select code, bit 1
3	XDS2	External, bus multiplexer select code, bit 2
4	XDS3	External, bus multiplexer select code, bit 3
5	XDS	Forces bus multiplexer control to external code (XDS0 through XDS3)
6-25	XD0-XD19	External data input bus, bits 0 through 19
26-45	DX0-DX19	External data output bus, bits 0 through 19
46	$\overline{\text{X IN DATA WRITE PULSE}}$	.5 μsec high to low pulse whenever data is written into the input buffer memory

Pin	Mnemonic	Explanation
47	X INT AD EN	Controls source of data into input buffer memory: high = internal A/D converter data low = external data on DX bus
48	Ground	
49	DX READ	Negative 2 μsec pulse signifying that the 440 is outputting data on the DX bus
50	Ground	

2. J-102 - 50 pin card edge connector with pin assignments as follows:

Pin	Mnemonic	Explanation
1	$\overline{\text{X 2 MS CLK}}$	High to low .5 μsec pulse every 2 msec
2	$\overline{\text{X PC LD INH}}$	Low level inhibits loading of program-counter. Normally high to enable loading
3-7	$\overline{\text{X FLG 0 - X FLG 4}}$	Five flags individually activated by low levels to signal 440 for appropriate action
8	$\overline{\text{X HALT}}$	Forces system to repeat current logic step as long as signal is held low
9	$\overline{\text{X PADV EN}}$	When low inhibits all 440 logic steps and enables external stepping clock $\overline{\text{X PADV}}$
10	X PADV	Enabled by $\overline{\text{X PADV EN}}$. Low to high transition causes the system to advance one logic step
11	LOAD PCX	High level indicates that Program Counter is being loaded
12	Spare	
13	X AVG SWEEP	High level during spectrum or time data display
14	$\overline{\text{X LD PC}}$	Low input to load Program Counter
15	X LD PC SYNC	Synchronized version of Signal 14
16-25	PC0-PC9	Program Counter outputs 0 thru 9
26	$\overline{\text{X STOP}}$	Pulse, high to low to high, input, parallels front panel STOP button activation

Pin	Mnemonic	Explanation
27	$\overline{\text{X ERASE}}$	Pulse, high to low to high, input, parallels front panel ERASE button activation
28	$\overline{\text{X RESET}}$	Pulse, high to low to high, input, parallels front panel RESET button activation
29	$\overline{\text{X START}}$	Pulse, high to low to high, input, parallels front panel START button activation
30	$\overline{\text{X HOLD/REL}}$	Pulse, high to low to high, input, parallels front panel HOLD/REL button activation
31	$\overline{\text{X ARM}}$	Pulse, high to low to high, input, parallels front panel ARM button activation
32	$\overline{\text{X BLK SYNC}}$	Pulse, high to low to high, input, minimum 2 μsec low to clear Buffer Full level and input buffer sample counter
33	$\overline{\text{X BUFF FULL}}$	Normally high output. Goes low whenever buffer is full. Returns to high level when $\overline{\text{X BLK SYNC}}$ is issued
34	$\overline{\text{X AD READY}}$	Pulse, high to low to high, input; causes XD0 thru XD10 to be written into input buffer whenever X INT AD EN is low
35	PC 10	Program Counter, bit 10
36	$\overline{\text{STOP ON FULL}}$	Low input causes input buffer to stop when full
37	X STB 0	Unassigned
38	X STB 1	Unassigned
39	X STB 2	Pulse used to transfer data to 66-2A
40	X PADV EN	Same as Signal 9 except inverted and synchronized to internal clock
41	$\overline{\text{X STB 3}}$	Complement of AVG TRIG OUT BNC
42	$\overline{\text{RESET NRT}}$	Pulse indicating end of non-redundant data
43	$\overline{\text{X RTC INH}}$	Display inhibit/plotter stall
44	GRD	
45-50	Spare	

F. CUR. AMP. OUT
Connector (Rear Panel)

This connector is used to provide an analog output signal (corresponding to the signal amplitude of the cursor location) to an external device such as a strip chart recorder. The output signal amplitude goes from +.33 to 3.42 volts as does the Plotter Y output (J7).

In CAL 0-0 this output corresponds to the bottom of the graticule. In CAL FS-FS this output corresponds to the top of the graticule.

The rest at cursor output is valid only when a cursor is displayed on the CRT or when in the CAL 0-0 or CAL FS-FS modes.

SECTION IV

CHECKOUT PROCEDURE USING INTERNAL TEST SIGNAL

4-1. Scope of This Section

This section of the instruction manual contains a step by step procedure of checking out the 440 using the internal TEST signal. Verification of the required result is seen on the display.

4-2. Initial Settings

Set front panel controls as indicated in Figure 4-1. Set ANNOTATION switch on the rear panel to the FULL position. Verify that the display corresponds to that shown in Figure 4-1.

4-3. Graticule Annotation Check

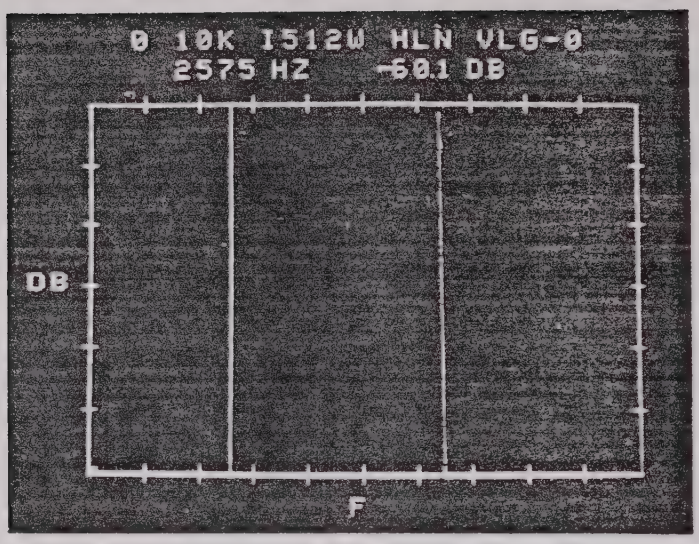
A. Vary INPUT AMPLITUDE COARSE and FINE controls through all combinations of settings. Verify that the annotation reading in Field 1 equals the sum of the dB markings of these two controls.

B. Vary FREQUENCY RANGE control through its full range. Verify that Field 2 of the annotation correctly displays the selected range. Note that frequency ranges from 1000 Hz through 20,000 Hz are displayed as 1K through 20K, respectively.

C. Verify each of the six letters in Field 3 of the annotation as follows:

T = VIEW TIME pressed
I = VIEW SPECT pressed
S = VIEW AVERAGE and SPECTRUM AVERAGE SUM pressed
D = DIFF
X = EXPON
P = PEAK

D. Vary the NUMBER-N control through all positions and verify the display in Field 4 of the annotation to match the legend of each switch setting. Note that in the CONT position of this switch the letters CON will be displayed.



CONTROL SETTINGS	
CONTROL	SETTING
POWER	ON
INPUT AMPLITUDE	
TEST/AC/DC	TEST
AMPLITUDE Indicators	A11 ON
OVERLOAD Indicator	OFF
COARSE	100 mv (0 dB)
FINE	0 (dB)
FREQUENCY RANGE	10,000 Hz
FREQ/ORDERS	FREQ
VIEW	INST SPECT
SPECTRUM AVERAGE	SUM
NUMBER-N	512
FREQUENCY	
READING	Hz
SCALE	LIN
AMPLITUDE	
SCALE	LOG
GAIN	0 dB
CURSOR	SINGLE
OUTPUT	CRT
DATA (WEIGHTING)	CONTIN (WT'D)
DATA HOLD	REL
HOLDING Indicator	OFF
AUTO ARM	OFF
ARMED Indicator	OFF
TRIG LEVEL	CENTER POSITION

FIGURE 4-1. INITIAL SETTINGS

E. Verify Field 5 of the annotation by switching DATA (WEIGHTING) selector from CONTIN (WT'D), and noting the letter "W", to TRANSIENT (UNWT'D) and noting the letter "U".

F. Verify Field 6 of the annotation by FREQUENCY SCALE switch as follows:

HLN = LIN position
HLG = LOG position

G. Verify Field 7 of the annotation by the AMPLITUDE SCALE switch as follows:

VLN = LIN position
VLG = LOG position

H. With the AMPLITUDE SCALE switch in the LOG position, verify that Field 8 of the annotation matches the DISPLAY MAX switch dB readings.

With the AMPLITUDE SCALE switch in the LIN position, verify that Field 8 of the annotation matches the DISPLAY GAIN "X" readings.

4-4. Graticule Check

A. Restore front panel settings to those shown in Figure 4-1. Note the following:

1. "DB" label outside left vertical graticule

2. "F" label below bottom horizontal graticule

3. Ten equally spaced intervals along top and bottom graticule lines separated by nine ticks.

4. Six equally spaced intervals along left and right graticule lines.

B. Set VIEW switch to AVER and verify that the graticule presentation remains unaltered.

C. Set VIEW switch to TIME and note the following:

1. "DB" label disappears

2. The letter "T" replaces the letter "F" below the bottom graticule line.

3. Top and bottom lines of graticule are divided into 12 equal intervals, separated by 11 ticks.

4. Left and right graticule lines are divided into 10 equal intervals, separated by 9 ticks.

D. Set VIEW switch to INST SPECT, AMPLITUDE SCALE switch to LIN, and FREQUENCY SCALE switch to LOG. Note the following:

1. "DB" label disappears.

2. The letter "F" appears below bottom graticule.

3. Vertical scale is divided into 10 equal intervals, separated by 9 ticks.

4. Horizontal scale is divided into 3 intervals, separated by 2 ticks.

4-5. CURSOR Check

A. Restore front panel settings to those shown in Figure 4-1. Perform the following checks:

1. Activate the LEFT CURSOR CONTROL and release immediately. Note that the leftmost field of the lower row of annotation fields (i.e., the frequency coordinate of the cursor) is reduced by 25 Hz and that the cursor has moved one increment to the left.

2. Activate the RIGHT CURSOR CONTROL and release immediately. Note that the frequency coordinate of the cursor is now incremented by 25 and that the cursor has single stepped one position to the right.

3. Activate the LEFT CURSOR CONTROL and hold. Note that after an initial delay of approximately two seconds, the cursor will slew leftward at a rate of approximately 500 Hz per second for the 10,000 Hz frequency range selected. Note that after passing the origin the cursor will fold back to the full scale, or 10,000 Hz, and the corresponding reading will appear.

4. Repeat for the RIGHT CURSOR CONTROL and note similar results. Note that at 10,000 Hz the cursor will fold back to the origin, or 25 Hz.

5. Set FREQ/ORDERS switch to ORDERS. Note that the frequency coordinate readout of the cursor now reads in percent full scale.

6. Set VIEW switch to TIME. Note the disappearance of frequency and amplitude coordinate readouts. Restore switch setting to SPECT.

7. Use LEFT or RIGHT CURSOR CONTROL until cursor is at 2000 Hz. Set READ switch to CPM and note reading of 120000 CPM. Restore original switch setting.

8. Position the cursor at 1000 Hz. Set CURSOR switch to HAR. Note the following: The lower graticule line is intensified at each of the nine tick marks, with each interval of intensification one position longer than the previous one to a maximum of five intensified points. Return CURSOR to SINGLE position.

9. Set VIEW switch to AVER and press ERASE. Note that the right field of the cursor readout will display the following values for the various settings of the DISPLAY MAX switch:

DISPLAY MAX SETTING	CURSOR AMPLITUDE READOUT
0 dB	-60.1 DB
-10 dB	-70 DB
-20 dB	-80 DB

10. Position the cursor at 6400 Hz. Set VIEW switch to INST SPECT. Note that intensified spot will be located near the full scale point on the graticule when the DISPLAY MAX switch is in the 0 dB position. Verify the following cursor amplitude readouts:

DISPLAY MAX SETTING	CURSOR AMPLITUDE READOUT
0 dB	-1 to -3 DB
-10 dB	-9.9 DB
-20 dB	-19.9 DB

11. Set VIEW to INST SPECT and DISPLAY MAX to 0 dB. Set AMPLITUDE SCALE to LIN. Note that the cursor amplitude readout at 6400 Hz remains unchanged and that the intensified spot has moved down on the vertical scale by about 1-1/2 divisions.

12. Switch FREQUENCY SCALE to LOG and note that cursor readouts remain unchanged. Note that the intensified spot at 6400 Hz has now moved from 64% of the horizontal scale to 92.5% of the horizontal scale.

13. Set ANNOTATION switch on rear panel to GRAT. Note that the annotation line above the cursor coordinate readout disappears and that the rectangular graticule and axis labels remain displayed.

14. Set ANNOTATION switch to OFF. Note that both the annotation and the entire graticule disappear but that the cursor readout remains displayed.

4-6. INPUT AMPLITUDE Check

A. Set front panel controls as indicated in Figure 4-1. Position the cursor at 6400 Hz and note the reading should be approximately -1 to -3 dB.

B. Vary the FINE INPUT AMPLITUDE control and note that for each successive counterclockwise position of this switch, the signal, and the cursor readout, are reduced by 1 dB $\pm$.1 dB. Restore 0 dB switch setting.

C. Rotate COARSE INPUT AMPLITUDE control and note that the displayed signal and the cursor readout are reduced by 10 dB $\pm$0.5 dB for each successive counterclockwise position of this switch. Restore original 0 dB setting.

D. Note that when the cursor readout is above -6 dB, all four indicators in the INPUT AMPLITUDE indicator group are on. As the signal is attenuated (using FINE and COARSE INPUT AMPLITUDE control) to below -6 dB, the corresponding indicator goes off. At -12 dB and below, the -12 dB indicator is also off. Similarly, verify that the -18 dB and -24 dB indicators switch off at their corresponding amplitude thresholds.

E. With the cursor set to 6400 Hz note the amplitude and position of signal. Rotate FREQUENCY RANGE control through all

positions and note that the cursor position remains at 64% of the horizontal scale. Also note that the amplitude of the signal under the cursor remains constant to within .2 dB. Return FREQUENCY RANGE switch to 10,000 Hz.

F. To test external sampling, it will be necessary to connect a signal generator to FREQ/ORDERS BNC connector on the front panel. The signal generator should be capable of providing a stable, repetitive waveform from 10 Hz to 60 kHz at 1 volt rms. or 3 volts peak to peak.

Set the FREQ/ORDERS switch to ORDERS and adjust the signal frequency to 25.6 kHz. Note that the position of the signal will again be very nearly at 64% of the band. Change the frequency to 16.5 kHz and note that the signal is now positioned near the end of the horizontal scale. Change the frequency to 40.6 kHz and note that the signal is now positioned at 40% of horizontal full scale.

Return FREQ/ORDERS switch setting to FREQ. Remove signal generator.

G. To test DATA HOLD and TRIG LEVEL, take the following steps:

1. With the front panel settings in the positions as shown in Figure 4-1, adjust the TRIG LEVEL to its maximum counterclockwise position (-1/2), and press AUTO ARM. Note that the HOLDING indicator should come on. Release HOLD.

2. Set COARSE INPUT AMPLITUDE control to -10 dB and press AUTO ARM. ARMED indicator will come on and HOLDING indicator will remain off. Now move TRIG LEVEL one position clockwise and HOLD indicator should come on.

3. This test may be repeated for all FINE and COARSE INPUT AMPLITUDE settings and all TRIG LEVEL positions. When the AUTO ARM button has been depressed, the ARMED indicator should remain on, until the AMPLITUDE and/or TRIG level are set so that the input signal crosses the trigger level setting. At that point, the HOLDING indicator should come on.

4. Repeat the test for positions of the TRIG LEVEL control starting at the maximum clockwise position (+1/2). Results should be identical for each positive setting as for the corresponding negative settings.

4-7. AMPLITUDE and FREQUENCY SCALE Check

A. Set front panel controls as indicated in Figure 4-1. Position the cursor on top of the peak of the displayed signal, i.e., at 6400 Hz. Vary the INPUT COARSE AMPLITUDE control in 10 dB steps and note that the intensified spot moves equal increments vertically, i.e., one vertical division per 10 dB.

B. Set the AMPLITUDE SCALE switch to LIN and repeat step A, above. Note that the signal is now reduced by a factor of approximately 3 for each switch rotation of the COARSE INPUT AMPLITUDE.

C. Set FREQUENCY SCALE switch to LOG. Verify the log scale by placing cursor at 1000 Hz and at 100 Hz, and noting that each of these coordinates places the cursor on a tick mark.

4-8. OUTPUT Check

A. Set the front panel settings to those shown in Figure 4-1, and check the internal CRT for the following:

1. Depress OUTPUT STORE CRT. Activate START switch and release. Note that a single sweep of the entire display will interrupt the normal fast display.

2. Depress OUTPUT X-Y PLOT. Depress RESET and START in that order. After a delay of approximately one second, a single very slow sweep will take place.

3. Repeat step 2 and press STOP while plot sweep is in progress. Sweep should halt. Press START and sweep should resume. Press RESET and fast CRT sweep should reappear; note audible click of relay contact opening.

4. Press OUTPUT CAL 0-0. Spot should appear at lower left position of CRT. Press OUTPUT CAL FS-FS and spot should appear at top right position of CRT. Return OUTPUT switch to original CRT setting.

B. To verify that the three plotter output connectors, J6 thru J8, provide the correct signals, connect the X and Y terminals of a plotter to J6 and J7, respectively. Connect the plotter pen-lift terminal to J8. If the plotter is not equipped

with a pen-lift terminal, a continuity check can be made at the pen-lift BNC. Note that for all conditions other than active plotting, the X and Y plotter output signals are clamped to near 0 volts. (X = .7 volts, Y = .33 volts.) The pen-lift output contacts are open circuited for the same conditions.

1. When the OUTPUT X-Y PLOT is depressed and START is pressed, the X and Y plotter output connectors provide a set of signals that correspond to the internal X and Y deflection signals. The pen-lift contacts will close during plotting.

2. If plotting is interrupted by STOP, the X, Y, and pen-lift plotter output signals remain active, i.e., they remain unclamped. If RESET is activated, X and Y return to their clamped values and pen-lift contacts are open-circuited.

3. If either OUTPUT CAL 0-0 or OUTPUT CAL FS-FS are pressed, the X and Y plotter output signals assume 0-0 or FS-FS, respectively; however, pen lift remains open-circuited.

4-9. DATA (WEIGHTING) Check

A. With the DATA (WEIGHTING) switch in the CONTIN (WT'D) position and the front panel switches set up as in Figure 4-1, set the CURSOR switch to the SINGLE position and observe the following:

1. By moving the CURSOR, you will note that the displayed signal near 6400 Hz has 3 distinct points: a peak at 6400 Hz and two points, both 6 dB below the peak value, located at 6375 Hz and 6425 Hz.

B. Set the DATA (WEIGHTING) switch to TRANSIENT (UNWT'D) and observe the following:

1. The value of the signal at 6375 Hz and 6425 Hz has now been reduced to -60.1 dB.

4-10. SPECTRUM AVERAGE Check

A. Set front panel as shown in Figure 4-1 with the following exceptions:

1. VIEW switch in AVER

2. CURSOR switch in OFF

3. ANNOTATION switch, rear panel, in OFF

B. Activate ERASE, RESET, and START, in that order. Note the IN-PROCESS indicator flashing for approximately one minute and then remaining off. This indicates that averaging has been completed. Set CURSOR to SINGLE and measure the amplitude of TEST signal at 6400 Hz. It should be approximately 0 to -3 dB. Set CURSOR to OFF.

C. Depress the SPECTRUM AVERAGE DIFF button. Depress the RESET and START in that order. Make sure not to press ERASE. Note that after one minute the IN-PROCESS indicator again stops flashing. Set the CURSOR switch to SINGLE and measure the amplitude of the TEST signal at 6400 Hz. Note that it will be -60.1 dB for the DISPLAY MAX switch setting of 0 dB. Set CURSOR switch to OFF.

D. Set SPECTRUM AVERAGE to EXPON. Activate ERASE, RESET, and START in that order and note that after approximately one minute, the IN-PROCESS indicator will stop flashing and remain on. When this occurs, immediately press STOP and set CURSOR to SINGLE and measure the amplitude of the TEST signal at 6400 Hz. Note that its value will be approximately 2 dB less than that obtained in paragraph C, above.

E. Set TEST/INPUT SIGNAL switch to INPUT. Depress RESET and START in that order and note that when IN-PROCESS indicator stops flashing, the value of the TEST signal at 6400 Hz will be approximately 4.5 dB less than that obtained at the end of paragraph D, above.

F. Set SPECTRUM AVERAGE to PEAK, COARSE INPUT AMPLITUDE to 10V (40 dB), TEST/INPUT to TEST, CURSOR to SINGLE. Activate ERASE, RESET, and START in that order and note that the averaged test signal at 6400 Hz immediately assumes a value between -40 and -41 dB. Wait until averaging is complete and verify that this value has not changed.

G. Change COARSE INPUT AMPLITUDE to 3.2V (30 dB) and press START and release. Note that the signal amplitude reading immediately jumps to approximately -31.2 dB.

H. Repeat step G for COARSE INPUT AMPLITUDE control set at (20 dB), (10 dB), and (0 dB) and note that in each case a single average cycle activated by the START switch will cause the signal amplitude to jump to -21.3 dB, -11.4 dB, and -1.5 dB, respectively. Note that these values are nominal and may vary by $\pm$.5 dB.

I. Tests performed in this paragraph, 4-10, SPECTRUM AVERAGE Check, may be repeated for various settings of the NUMBER-N control. Results should be identical except that the nominal one second time constant observed for N = 512, will be reduced almost proportionately for the smaller N settings. The following table shows the duration for SUM averaging for various NUMBER-N settings; for the conditions of ANNOTATION and CURSOR switches in the OFF positions (for which the fastest averaging is obtained); for the ANNOTATION switch in the FULL position, and the CURSOR switch in the SINGLE position (for which slow averaging is obtained). See Table 4-1 on page 4-12.

J. Set the NUMBER-N switch to CONT and turn CURSOR and ANNOTATION switches to OFF positions. SUM AVER for 104 seconds and press STOP. Set CURSOR switch to SINGLE and measure signal amplitude at 6400 Hz. Note that this value will be very close to the full scale value of the TEST signal, verifying that the CONT position of the NUMBER-N switch scales the signal by 1024. Press START and verify that averaging will continue indefinitely until STOP or RESET are pressed.

K. Perform SUM AVER in CONT position of NUMBER-N switch. While averaging press ERASE and verify that signal is reduced to -60.1 dB reading immediately upon release of ERASE button and then continues to build up from that point.

4-11. VIEW TIME Check

A. Set the front panel settings to the positions shown in Figure 4-1.

1. Depress VIEW TIME switch and verify that a display of the TEST signal appears occupying approximately 80% of the vertical scale and 85% of the horizontal scale. Note that the following switches will affect the annotation but not the signal display:

a. AMPLITUDE SCALE - LIN/LOG
b. AMPLITUDE - GAIN/MAX
c. FREQUENCY - LIN/LOG

NUMBER-N SETTING	FREQUENCY RANGE (Hz)	SUMMATION AVERAGING TIME (SECONDS)	
		MINIMUM DISPLAY	MAXIMUM DISPLAY
512	10,000	61	110
256		31	54
128		16	28
64		8	14
32		4	7
16		2	3.5
8		1	2
4		1/2	1
2		1/4	1/2
1		1/8	1/4
512	20,000	61	110
32		4	7
512	5,000	61	110
32		4	7
512	2,000	61	110
32		4	7
32	1,000	103	110
		7	7
32	500	13	13
	200	31	31
	100	62	62
16	50	59	59
8	20	69	69

Note that the above readings are nominal and that actual times may depart from these readings by $\pm$5%.

TABLE 4-1. TIMES FOR SUMMATION AVERAGING AS A FUNCTION OF NUMBER-N SETTING

SECTION V

440 INPUT AND OUTPUT INTERFACE

5-1. Scope of This Section

The Model 440 communicates with other equipment by means of a self-contained visual display system and rear panel input and output connectors. This section discusses a number of external devices that can be interfaced with the 440 and the signals required for proper communication. These devices include:

A. An X-Y Plotter
B. External Storage CRT Display (Option -03)
C. External Display Source (into the 440)
D. External Source of Front Panel Commands or Sense (Option -06)
E. External Source of Digital Data (into the 440)
F. External Device to Read Data from the 440

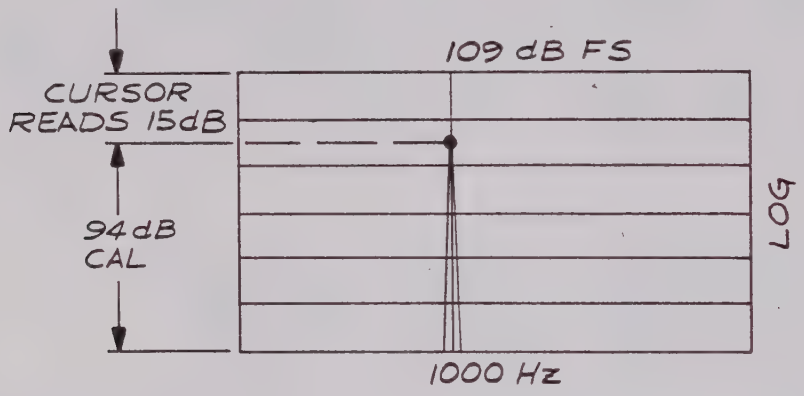
5-2. X-Y Plotter Interface

To interface with any X-Y Plotter it is simply necessary to connect the X and Y TO PLOTTER outputs at the rear panel of the 440 to the corresponding inputs of the plotter. The PEN LIFT can be used if the plotter is equipped with a corresponding input command. Otherwise, the pen must be manually lowered or raised in the plot mode.

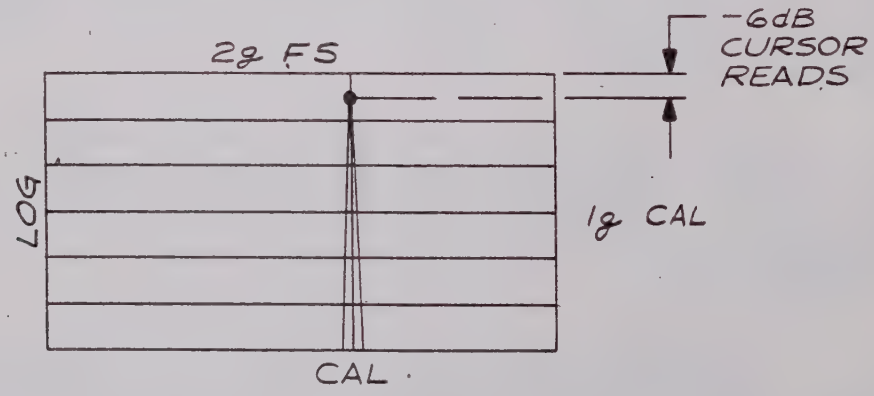
Both X and Y signals are normally clamped to a small positive voltage when not in an active plot mode. However, when the CAL 0-0 or CAL FS-FS switches are pressed, the signals are unclamped and will provide the proper calibration voltage levels to the plotter.

To calibrate a plotter when the 440 is given a calibration signal only requires the measurement of the calibration signal peak with the cursor. The number obtained is then used to determine a numerical value for the FS (full scale) vertical CAL point. The FS point is located on the plotter establishing an absolute calibration for the Y axis.

One example is where the input CAL signal represents a specific dB level. This can be obtained when using a sound level calibrator with a sound level meter. One commercially available calibrator will give a 94 dB signal at 1000 Hz. The 440 spectrum would then show one peak at 1000 Hz. Place the cursor on that peak and measure its dB value below full scale. By adding this number to the 94 dB will give the value of the 440 full scale calibration point.



When the input CAL signal does not represent dB but rather a specific value like acceleration (g's) the dB measured by the cursor must then be converted to its voltage ratio and this value then is used to multiply the CAL level to obtain the value of the FS point. As an example: If the CAL signal is 1g and its peak measures -6 dB, then the FS level is (1g) X (2) = 2g, since 6 dB is equal to a voltage ratio of 2:1.



The X and Y TO PLOTTER outputs will follow the display information when the OUTPUT switch is in the X-Y PLOT position and the START button is pressed.

5-3. External Storage CRT Display Input

To interface with an external storage such as the Tektronix 613/611, it is necessary to provide the X, Y, and Z-axis outputs from the rear of the unit to the corresponding inputs on the storage display. Note that the 613/611 Z-AXIS output is a TTL level, which is normally low and goes high whenever the storage display Z-axis is to be turned on. To write a single display readout on the 613/611, it is necessary to place the OUTPUT switch in the STORE CRT position and to press START. A single display readout will then be transferred onto the storage scope. Graticule and annotation, as well as cursor, if enabled, will be included in this transfer.

5-4. External Display Source into the 440

The 440 CRT may be used to display X and Y deflection signals provided by an external source. The X and Y outputs of the external source should be connected to the corresponding connectors at the rear of the 440, J4 and J5. Two slide switches on the 440 Display Board must be operated for external input display: INT/EXT must be set to EXT and Z-AXIS ON/OFF must be set to ON. This will keep the CRT Z-AXIS on continuously during the display of external data. The external X and Y input signals are specified to swing between 0 volts (left or bottom extreme) to +1 volt (right or top extreme). The maximum input frequency should be less than 500 kHz on either input.

5-5. External Source of Front Panel Commands or Sense

The 440 operates according to front panel switch settings, or external levels that replace these settings. Although individual switches cannot be selected for remote control substitution, portions of the -10 Plug-In unit may be selected for remote control and the upper 440 panel for local front panel control, or vice-versa. Alternatively, both upper and lower panels may be remotely controlled. The selection of local or remote control for either panel is achieved through signals appearing on the multipin connector at the rear of the unit. The sequence of timing operations is described in the following paragraphs.

The status of all front panel controls is provided via rear panel bus and control signals and is described in the paragraphs that follow:

A. Front Panel Sense - To sense front panel switch settings, or those commands that have replaced switch settings, the following signals are used:

DX 0 thru DX 19	J101, Pins 26 thru 45
$\overline{\text{DX READ}}$	J101, Pin 49

DX 0 through DX 15 contains 16 bits of coded front panel data which reflect the settings of the front panel switches, or external commands that replace them. DX 16 through DX 19 contain a four bit code that is used to indicate which portion of the front panel is currently on the top 16 bits. Whenever the $\overline{\text{DX READ}}$ signal becomes "true," i.e., a low level TTL, data on the lower 4 bits of the DX bus will indicate what information is present on the higher order 16 bits of the same bus. $\overline{\text{DX READ}}$ normally goes low for two microseconds whenever the 440 outputs data on the DX bus.

Note that not all front panel settings can be sensed remotely, i.e., CURSOR and CURSOR CONTROL. The following table presents the DX bus assignment for the top 16 bits as a function of the code appearing on the bottom four bits. (Table 5-1.)

The following Tables 5-2 through 5-5 should be used as a cross reference with Table 5-1, and indicate the significance of the codes assigned to each switch or switch group.

When the 440 accepts the remote FINE ATTENUATOR setting (see Table 5-7, Code 2 = 0010 on DX16 through DX19) it does not execute the remote command as is the case with the other remote input commands. The FINE ATTENUATOR command is compared with the local front panel FINE INPUT AMPLITUDE setting and if these commands are not identical, an apostrophe (') is displayed on the CRT in the character position immediately to the right of the total INPUT AMPLITUDE control settings. The apostrophe signifies mismatch between local and remote FINE INPUT AMPLITUDE commands.

TABLE 5-1. DX BUS ASSIGNMENT DURING DX READ TIME

REFER TO	DX 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	DX 16	17	18	19	DECIMAL CODE DX16-19	SIGNIFICANCE OF DX0-DX15
TABLE 5-2	DG 0	DG 1	H LOG	V LOG	HW	VU 0	VU 1	AM 0	AM 0	DM 0	DM 1	DM 2	NO. OF AVG 0	1	2	3	0	0	0	0	0	SENSE GROUP 0 (UPPER PANEL)
TABLE 5-3	AMPL 2	AMPL 1	AMPL 0	FR 3	FR 2	FR 1	FR 0	POS 1	LEV 0	LEV	INP EN	XS EN	HOLD	ARM	DC EN	0	0	0	0	1	1	SENSE GROUP 1 (LOWER PANEL)
TABLE 5-4	FINE ATT 0	1	2	3	AMP/ OVERLOAD 0	1	2	0 ←								→ 0	0	0	1	0	2	SENSE GROUP 2 (FINE ATT & OVERLOAD)
TABLE 5-5	AVG IN PROC 0		0	0	0	AN 0	AN 1	Start	Stop	Erase	A	B	C	D	E		0	0	1	1	3	SENSE GROUP 3 (ANNOT, START, STOP, ERASE, MISC)
NOTE 1	MSB ←		-i	LSB →		0	1 MSB ←		f							LSB →	0	1	0	0	4	SPECTRUM OUT (FLOAT.POINT)
NOTE 2	SIGN MSB ←			±f	LSB →	0	0	0	0	0							0	1	0	1	5	TIME DATA (BIPOLAR, FXD PT.)
NOTE 2	SIGN MSB ←			±f						LSB →	0	0					0	1	1	0	6	REAL, IMAG ALT. OUTPUT
	TIME	LAST POINT	0 ←													→ 0	0	1	1	1	7	(BIPOLAR, FXD PT.) DX2-15 UNDEF; CODE = PLOT POINT IDENT.
	UNDEFINED																1	0	0	0	8	SPARE
	UNDEFINED																1	0	0	1	9	SPARE
	UNDEFINED																1	0	1	0	10	SPARE
	UNDEFINED																1	0	1	1	11	SPARE
NOTE 3	MSB ←			CURSOR LOCATION			LSB →	0	0	0	0	0	0	0			1	1	0	0	12	CURSOR LOCATION
NOTE 4	MSB ←			N_A			LSB →	⩾N	0	0	0	0	0				1	1	0	1	13	NO. OF AVG COMPLETED, AND ⩾N
	UNDEFINED																1	1	1	0	14	DX0-15 UNDEF; CODE = POS INPUT ACK
	UNDEFINED																1	1	1	1	15	DX0-15 UNDEF; CODE = NEG INPUT ACK

NOTE 1: THE SPECTRUM VALUE = 2^{-i} (1 + f), WHERE -i = -1 TO -31; f = 0 to .999

NOTE 2: ± f = 0 to ± .999

NOTE 3: CURSOR LOCATION = 1 to 400

NOTE 4: N_A = 0 to 1023 ; ⩾N = HIGH WHEN N_A EQUALS OR EXCEEDS N

TABLE 5-2. DX BUS SIGNIFICANCE FOR SENSE GROUP 0

SYMBOL USED	CORRESPONDING FRONT PANEL INDICATOR OR CONTROL SETTING
DG0 DG1	DISPLAY
0 0	X1/0 dB
1 0	X4/-10 dB
1 1	X16/-20 dB
HLOG	FREQ SCALE – LOG
VLOG	AMPLITUDE SCALE – LOG
HW	DATA (WEIGHTING) – CONTIN (HANNING)
VU0 VU1	VIEW
0 0	TIME
0 1	INST SPECT
1 0	AVER
AM0 AM1	SPECTRUM AVERAGE
0 0	SUM
0 1	DIFF
1 0	EXPON
1 1	PEAK
DM0 DM1 DM2	OUTPUT
0 0 1	CRT
0 1 0	STORE CRT
0 1 1	X-Y PLOT
1 0 0	CAL 0-0
1 0 1	CAL FS-FS
NO. OF AVG	SPECTRUM AVERAGE NUMBER-N
0 1 2 3	
0 0 0 0	1
0 0 0 1	2
0 0 1 0	4
0 0 1 1	8
0 1 0 0	16
0 1 0 1	32
0 1 1 0	64
0 1 1 1	128
1 0 0 0	256
1 0 0 1	512
1 0 1 0	CONT

TABLE 5-3. DX BUS SIGNIFICANCE FOR SENSE GROUP 1

SYMBOL USED	CORRESPONDING FRONT PANEL INDICATOR OR CONTROL SETTING
AMP 2 AMP 1 AMP 0	COARSE INPUT AMPLITUDE
0 0 0	100 MV (0 dB)
0 0 1	316 MV
0 1 0	1 V
0 1 1	3.2 V
1 0 0	10 V
FR 3 FR 2 FR 1 FR 0	FREQUENCY RANGE
0 0 0 0	10 Hz
0 0 0 1	20
0 0 1 0	50
0 1 0 0	100
0 1 0 1	200
0 1 1 0	500
1 0 0 0	1,000
1 0 0 1	2,000
1 0 1 0	5,000
1 1 0 0	10,000
1 1 0 1	20,000
POS LEV 1 LEV 0	TRIG LEVEL
0 0 0	-1/2
0 0 1	-1/4
0 1 0	-1/8
0 1 1	-1/16
1 1 1	+1/16
1 1 0	+1/8
1 0 1	+1/4
1 0 0	+1/2
$\overline{\text{INP EN}}$	TEST/INPUT SIGNAL – TEST
$\overline{\text{XS EN}}$	FREQ/ORDERS – FREQ
HOLD	HOLD
ARM	ARMED
$\overline{\text{DC EN}}$	(UNITS 61 AND UP: LOW = DC COUPLING)

TABLE 5-4. DX BUS SIGNIFICANCE FOR SENSE GROUP 2

SYMBOL USED				CORRESPONDING FRONT PANEL INDICATOR OR CONTROL SETTING
FA 0	FA 1	FA 2	FA 3	FINE INPUT AMPLITUDE
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
AMP/OVERLOAD 0		1	2	INPUT AMPLITUDE/OVERLOAD
0		0	0	OVERFLOW
0		0	1	-6 dB
0		1	0	-12 dB
0		1	1	-18 dB
1		0	0	-24 dB

TABLE 5-5. DX BUS SIGNIFICANCE FOR SENSE GROUP 3

SYMBOL USED	CORRESPONDING FRONT PANEL INDICATOR OR CONTROL SETTING
AVG IN PROC	IN PROCESS
AN 0 AN 1	ANNOTATION REAR PANEL
1 1	FULL
0 1	GRAT
0 0	OFF
START	START
STOP	STOP
ERASE	ERASE
A	FRONT PANEL OPTION SWITCH 1
B	2
C	3
D	4
E	5

If the $\overline{\text{DX READ}}$ is sensed but the external device is not ready to accept the data which is flagged by the code on the bottom four bits of the DX bus, the 440 can be locked into the condition that the bus will remain static with the desired data until it is permitted to progress to other values. To achieve this, a low TTL level must be applied to J102, pin 9, $\overline{\text{XPADVEN}}$, no later than two microseconds following the leading, or falling edge of the $\overline{\text{DX READ}}$ strobe. When the external device is ready to accept the data on DX0 through DX15, it must then provide its own strobe to clock the 16 bits of the DX bus into its register, or memory. Following this action, $\overline{\text{XPADVEN}}$ must be returned to a high (or open) state so that the 440 can continue stepping through its internal operations.

It is important to note that the DX0 through 19 bus is never defined to the outside world except either during the two microsecond $\overline{\text{DX READ}}$ strobe or anytime that the $\overline{\text{XPADVEN}}$ is low, provided that it was brought low during the $\overline{\text{DX READ}}$ strobe low level duration.

B. Front Panel Remotely Controlled - To replace either upper or lower front panel controls, or both, with remote control commands, the XD0 through XD19 input bus must be used. This bus is available at J101, pins 6 through 25 respectively. In addition, $\overline{\text{XFLG0}}$, $\overline{\text{XFLG1}}$, and $\overline{\text{XFLG4}}$ must be used as follows:

To place upper front panel under remote control, $\overline{\text{XFLG0}}$ must go low.

To place lower front panel under remote control, $\overline{\text{XFLG1}}$ must go low.

(These signals appear at pins 3, 4, and 7 of J102, rear panel, respectively.)

When either of these two signals go low, the 440 will not respond to any further changes in control settings of the corresponding front panel. However, if remote commands are to be recognized, $\overline{\text{XFLG4}}$ must also go low. When the 440 recognizes $\overline{\text{XFLG4}}$, XD0 through XD15 must have the proper front panel data on it; XD16 through 19 must contain four zeroes (low levels) if the data on the XD0 through XD15 bus represents upper front panel data and a single logic 1 (high level) on XD19 if the data represents lower front panel data.

Recognition of the request to read in a remote front panel command word into the 440 is signified by the DX READ accompanied by a code in bits 16 through 19 of the DX bus. If the code is 1110, a positive acknowledge is signified. If the code is 1111, a negative acknowledge is signified. A negative acknowledge will result from a request that is not accompanied by one of the four legal codes on bits 16 through 19 of the XD input bus.

A positive acknowledge must be accompanied by the remote source removing the XFLG4 low level. If this level is not removed by the time the DX READ level goes high, the 440 will assume that another command is to be read into the system from the XD0 through XD15 bus.

A summary of control commands and busses used in the remote control operation of 440 front panel data is presented in Table 5-6.

5-6. External Source of Digital Data into the 440

A. The standard 440 is designed to accept digital data into its input buffer from an external source in a simple "handshake" mode of operation. The following signals are used in this operation:

1. XD0 through XD10 ..... J101, Pins 6 thru 16
2. X IN DATA WRITE PULSE ... J101, Pin 46
3. X INT AD EN ..... J101, Pin 47
4. X BUFF FULL ..... J102, Pin 33
5. X AD READY ..... J102, Pin 34
6. GROUND ..... J101, Pins 48 and 50
7. AVG. TRIG OUT ..... J9, BNC
8. X BLK SYNC ..... J102, Pin 32
9. DX16 thru DX19 ..... J101, Pins 42 thru 45
10. DX READ ..... J101, Pin 49

B. The specification for entering data into the 440 will be summarized below.

1. To enable loading of external digital data into the 440, the X INT AD EN signal must be put into the low state.

TABLE 5-6. REMOTE COMMANDS AND BUSSES USED IN REMOTE CONTROL OF FRONT PANEL COMMANDS

SIGNAL	CONNECTOR	FUNCTION
XD16 - XD19	J101, PINS 22 - 25	0 0 0 0 = REMOTE GROUP 0 0 0 0 1 = REMOTE GROUP 1
XD0 - XD15	J101, PINS 6 - 21	MUST CONTAIN GROUP 0 OR GROUP 1 CODES DEPENDING ON XD16 - 19 (CODE ASSIGNMENT IDENTICAL TO CORRESPONDING GROUP CODES ON DX BUS
$\overline{\text{XFLG0}}$	J102, PIN 3	LOW PLACES GROUP 0 OF UPPER PANEL UNDER REMOTE CONTROL
$\overline{\text{XFLG1}}$	J102, PIN 4	LOW PLACES GROUP 1 OF UPPER PANEL UNDER REMOTE CONTROL
$\overline{\text{XFLG4}}$	J102, PIN 7	LOW SIGNIFIES REQUEST FOR 440 TO READ XD0 THRU XD19
DX16 - DX19	J101, PINS 42 - 45	1 1 1 0 = POSITIVE INPUT ACKNOWLEDGE 1 1 1 1 = NEGATIVE INPUT ACKNOWLEDGE
$\overline{\text{DX READ}}$	J101, PIN 49	MUST BE LOW FOR DX16 - DX19 TO BE VALID

2. To initiate a block load of 1024 words, without the necessity of an external counter, the X BLK SYNC must be issued. X BLK SYNC must normally be in the high state; when activated, it must go low for at least 2 microsecond. The trailing edge, i.e., the transition from the low to the high state, will clear the 440 input buffer word counter and will force the status signal X BUFF FULL into the high state signifying that the input buffer count is now initialized at zero.

3. X AD READY pulses, minimum width equal to 1 microsecond in the low state, can be issued at any rate from dc to 150 kHz; each pulse trailing edge, i.e., low to high transition, will result in the data on the XD0 through XD10 bus to be gated into sequential locations in the input buffer memory. The X IN DATA WRITE PULSE is the acknowledge that the write into the buffer has actually taken place. This pulse is actively low for 1.0 microseconds each time a word is written into the input buffer. X AD READY should not be issued sooner than 0.5 microsecond following the trailing edge, i.e., the low to high transition, of the write acknowledge pulse.

4. When the 1024th X AD READY has been issued, the status signal X BUFF FULL will go low signifying that the input buffer is now full and that new input data will overwrite the oldest data sent in the previous block of 1024 words. Consequently, the X BUFF FULL signal is to be used to inhibit transmission of X AD READY pulses when in the low state.

5. The input buffer again becomes available when the 440 has read out its entire contents of 1024 words. This is signified by a high to low pulse, AVG TRIG OUT, available at J9, BNC, at the rear panel and at J102, Pin 42. This signal is normally high and goes low for 1/2 microsecond, signifying that the input buffer has been emptied and is again available for another block of 1024 words.

6. The external device can now issue another X BLK SYNC pulse which will cause the signal X BUFF FULL to go high. Loading of data can now proceed starting with Step 3.

7. If data is being averaged, each block of 1024 words loaded into the input buffer will result in one additional average. If averaging is to halt after "N" averages, as preset by the NUMBER-N control, and no additional blocks of 1024 words

are to be loaded from the external device after this point, DX16 through DX19 must be decoded and examined for the code 1101 (DX16 is the leftmost, or most significant bit of this four-bit group) at the time $\overline{\text{DX READ}}$ goes low. The presence of this code signifies that "N" averages, or more, have been completed. Note that this code, accompanied by $\overline{\text{DX READ}}$ will appear some time after the "Nth" block of 1024 words have been entered into the input buffer. Therefore, no additional block data loading should occur following receipt of the first 1101 code accompanied by $\overline{\text{DX READ}}$, the read strobe.

8. Data is frozen in the input buffer whenever the 440 is in HOLD or whenever $\overline{\text{X INT AD EN}}$ is low and $\overline{\text{X AD READY}}$ remains continuously high. To revert to internal data loading mode, it is essential that the $\overline{\text{X INT AD EN}}$ be released (floating) or brought to a logic high level (+3 to +5 volts).

5-7. External Source of Digital Data into the 440 Averager

An external device can transfer up to 400 data words representing the magnitude of a spectrum into the 440 averager memory as follows:

A. The external device must place each data word in succession on the XD0 through XD15 bus in accordance with the format indicated in Table 5-7. Bits 16 through 19 of the XD bus must contain the code 0100.

B. When the device data is on the XD bus it requests a transfer via the $\overline{\text{XFLG4}}$ input request signal located on J102, Pin 7, by holding this line low.

C. When the 440 recognizes the request, it will issue a $\overline{\text{DX READ}}$ on J101, Pin 49, signifying that the data on the XD0 through XD15 bus has been accepted by the 440. Data must remain stable on the XD bus until the $\overline{\text{DX READ}}$ is issued.

D. When the 440 issues the $\overline{\text{DX READ}}$, it will be accompanied by either one of two codes in the DX16 through DX19 bit positions of the DX bus. If the input request was accompanied by a valid code in XD16 through XD19, the acknowledge code from the 440 back to the external device will be 1110, signifying a positive acknowledge. If, on the other hand, the code was

invalid, the acknowledge code will be 1111, signifying a negative acknowledge. A negative acknowledge will result in the non-entry of data into the 440 averager and therefore should not be ignored.

E. If the external device is to transfer single data words with each input request, the XFLG4 signal must be restored to its inactive, or high state, before the trailing edge of the DX READ signal. Recall that this signal normally is low and goes high for 2 microseconds during the DX READ operation.

F. If the external device can provide data words at the appropriate rate, the XFLG4 signal may remain low provided that the next data word is stabilized on the XD bus within 2 microseconds following the trailing edge of the DX READ. In this manner a block of 400 words maximum may be entered in a single input request operation.

G. Successive words are entered into successive address locations in the averager memory. If the address is incremented to 400, the 401st entry will be in the first address and will overwrite the previous entry in that address.

H. To initialize the address, a local or remote RESET must be issued. If successive blocks of 400 words are transferred by the external device, the RESET need be issued only prior to the first 400 word block transfer.

I. An averager cycle which is in progress on the DX16 through DX19 bus when a "code 4" input request occurs, will be stopped and the running number of measurements count stored in the 440 will be reset to zero. Note that data that had been accumulated in the averager memory will be overwritten by the external device data.

J. External digital data entered into the 440 averager cannot be averaged on a block-by-block basis and is stored for display purposes only. Note also that this data does not have a signed fraction indicating that it must be unipolar or magnitude type data only.

TABLE 5-7. XD BUS ASSIGNMENT FOR REMOTE INPUT REQUEST (XFLG4)

REFER TO	XD 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	XD 16	17	18	19	DECIMAL CODE XD16-19	SIGNIFICANCE OF XD0-XD15
TABLE 5-2	DG 0	DG 1	H LOG	V LOG	HW	VU 0	VU 1	AM 0	AM 1	DM 0	DM 1	DM 2	NO. OF AVG 0	1	2	3	0	0	0	0	0	REMOTE GROUP 0 (UPPER PANEL)
TABLE 5-3	AMPL 2	AMPL 1	AMPL 0	FR 3	FR 2	FR 1	FR 0	POS	LEV 1	LEV 0	INP EN	XS EN	HOLD	ARM	DC EN	0	0	0	0	1	1	REMOTE GROUP 1 (LOWER PANEL)
TABLE 5-4	FA 0	FA 1	FA 2	FA 3	SPARE												0	0	1	0	2	REMOTE FINE ATTENUATOR
NOTE 2	SPARE																				3	SPARE NOTE 2
NOTE 1	MSB ← i → LSB							0	1 MSB ← f → LSB								0	1	0	0	4	SPECTRUM INPUT (FLOAT. POINT)
NOTE 2	SPARE																				5	SPARE NOTE 2
																					6	
																					7	
																					8	
																					9	
																					10	
																					11	
																					12	
																					13	
																					14	
																					15	

NOTE 1: THE SPECTRUM VALUE = 2^{-i} (1 + f), where -i = -1 to -31; f = 0 to .999

NOTE 2: ALL SPARE CODES ARE TREATED AS ILLEGAL IF ISSUED BY THE EXTERNAL DEVICE

5-8. External Device to Read Data from the 440

A. The standard 440 configuration permits the following types of data to be read from the system via the DX0 thru DX15 bus:

1. Upper Front Panel Commands
2. Lower Front Panel Commands
3. Fine Attenuator and Overload Status
4. Spectrum Data
5. Time Data

B. Each of these data words is identified by four bits, DX16 through DX19 and is valid only when $\overline{\text{DX READ}}$ is low, or if the 440 has been stalled during the low level of $\overline{\text{DX READ}}$, as outlined in paragraph 5-5A, above. In addition to the five data words which require an identification tag in the DX16 through DX19 portion of the bus, there are four codes in the DX16 through DX19 field of the DX bus that signify status or control only, and that do not accompany defined data in the upper portion, or the DX0 through DX15 field, of the DX bus. These controls are as follows:

1. Plot Point Identification
2. Acknowledge Input
3. Negative Acknowledge Input
4. Spectrum Average "N" or more, completed.

C. The list of available outputs and their corresponding identification codes appear in Tables 5-1 through 5-5.

1. Front panel commands are described in paragraph 5-5A above. Refer to the applicable paragraphs for the description of DX0 through DX15 for each front panel command word.

2. Spectrum data may be either instantaneous or averaged data, depending on the setting of the VIEW switch. Time data is obtained when the VIEW switch is in the TIME position.

Spectrum data is represented as a floating point binary number 2^{-i} (1 + f) and is formatted as follows:

a. DX0 through DX4: exponent of 2 as a twos complement number (-i). (Note that DX0 is the most significant bit.)

b. DX6 through DX15: mantissa expressed as 1 + f (DX6 = 1 always).

c. DX5 is always 0.

For example, the spectral value = 0.40625 is represented in fixed point binary notation as 0.011010...0. The 440 represents 0.40625 by the value 2^{-2} (1.625). The exponent -2 is represented as 11110 in bits DX0 through DX4 and the number 1.625 is represented as 1.1010..0 and appears in bit positions DX6 through DX15 with DX5 always equal to zero.

Spectrum data represents the power spectrum and thus has the units of volts squared. The dB weight of the exponent is obtained by multiplying it by 3.01. In the example above, the approximate dB value of the spectral datum is equal to 3.01 X (-2) = -6 dB. However, the exact value lies between -3 dB and -6 dB due to the 0 to 3 dB contribution of the mantissa. The dB value of 1.625 = 10 $\log_{10}$ (1.625) = 2.11 dB. Therefore, the exact value in dB of the value 2^{-2} (1.625) = -6 dB + 2.11 dB = -3.89 dB.

3. Time Data - Time data appears at the output whenever the TIME switch is selected for viewing. This data is presented as conventional fixed point twos complement binary data. Positive data is signified by a low level, or 0, in bit position DX0, followed by 10 bits of binary data in positions DX1 through DX10. DX11 through DX15 are always zero for time data outputs. Negative time data is represented by a high level, or logic 1, in bit position DX0, followed by a twos complement binary word in bits positions DX1 through DX10. DX11 through DX15 are equal to 0.

4. Plot Point Identification - Code 0111 in bits DX16 through DX19 at the time the $\overline{\text{DX READ}}$ is low signifies that a data word has just been entered into the 440 display digital-to-analog converter latch and is ready for plotting. This flag is useful in controlling the motion of an incremental plotter whose time (or frequency) axis is not being driven by the X output BNC (J6) of the 440 system.

5. Acknowledge Input - Code 1110 in bit positions DX16 through DX19 during the time that $\overline{\text{DX READ}}$ is low, signifies a positive acknowledge for data previously inputted to the 440 via the XD bus, i.e., upper or lower front panel commands from an external device.

6. Negative Acknowledge Input - This condition is represented by the code 1111 on DX16 through DX19 during the low level condition of DX READ and signifies that the inputted data on the XD bus contained an illegal code, i.e., neither of the two assigned input codes which include 0000 for the upper panel and 0001 for the lower panel in bit positions XD16 through XD19.

7. Spectrum Average "N" or more Completed - This condition is signified by the code 1101 in DX16 through DX19 bit positions when $\overline{\text{DX READ}}$ is low and signifies that the averaging process has been completed. This flag can be used to signal the external device to read an averaged spectrum into its memory or it can be used to terminate the block loading of time data into the 440 input buffer.

8. Spectrum Real and Imaginary Data - The code 0110 in bits DX16 through DX19 signifies that the top portion of the DX bus represents instantaneous spectrum real or imaginary data in alternating succession, i.e., the first spectrum output associated with this code is real, the next data word with this code is imaginary, etc., 400 real and 400 imaginary output data words have been transmitted. Real and imaginary spectrum data is formatted as bipolar twos complement binary with DX0 representing the sign of the word and DX1 through DX13 representing the magnitude in twos complement. DX14 and DX15 are always equal to zero.

9. Additional Front Panel Data - Sense Group 3 is signified by the code 0011 during $\overline{\text{DX READ}}$ time. The data on the DX bus at this time will contain the setting of the rear panel ANNOTATION switch, the START, STOP, and ERASE status, the five optional switches that can be added to the front panel, and an internal status signal AVERAGE IN PROCESS, signifying that the 440 is in an active averaging mode.

10. Cursor Location - Code 1100 on the DX16 through DX19 portion of the DX bus during the $\overline{\text{DX READ}}$ low level duration indicates that the position of the cursor as a number from 1 to

400 is contained in the top nine bits of the DX bus, i.e., DX0 through DX8. The remaining bits, DX9 through DX15 will be zero. The code 1100 will be issued only if the CURSOR switch is not in the OFF position. In addition the VIEW switch must not be in the TIME position if the cursor location is to be outputted.

11. Number of Averages Completed - The code 1101 on bits DX16 through DX19 signifies that the top portion of the bus, DX0 through DX9, will contain a binary integer from 0 to 1023 indicating the total number of averages completed up to 1023. The number will be limited to 1023 for continuous averaging or exponential averaging, where the number of averages increments continuously until another front panel command is issued. DX10 will indicate that "N" or more averages have been completed, where "N" is the setting of the SPECTRUM AVERAGE NUMBER-N front panel switch (or its remote command equivalent).

D. The standard 440 continually cycles through all digital outputs. Outputs are not requested but must be synchronized within the reading device. Figure 5-1 is a flow diagram showing the sequence of outputs.

As can be seen from this diagram, the cycle begins with the outputting of sense groups 0 through 3 (codes 0 - 3). Next the cursor location (code 12) is output if the cursor is on. This is followed by the real/imaginary data (code 6). Next the number of averages counter (code 13) is output. The time data (code 5) or spectrum data (code 4) is then output. Finally, a pulse is output on J9 to auto arm the transient capture feature if the average has been updated.

5-9. External Device Flags

A. Aside from the DX output and the XD input busses and the DX READ which are used for two-way communication between the 440 and an external device, there are five input flag signals that are used in conjunction with these busses. The names and locations of these signals at the rear panel connector are indicated as follows:

1. $\overline{\text{XFLG0}}$ ..... J102, Pin 3

2. $\overline{\text{XFLG1}}$ ..... J102, Pin 4

3. $\overline{\text{XFLG2}}$ ..... J102, Pin 5

4. $\overline{\text{XFLG3}}$ ..... J102, Pin 6

5. $\overline{\text{XFLG4}}$ ..... J102, Pin 7

The significance of the signals $\overline{\text{XFLG0}}$, $\overline{\text{XFLG1}}$, and $\overline{\text{XFLG4}}$ have been explained above in conjunction with the remote input of upper and lower front panel commands. Refer to paragraph 5-4A. At the present, $\overline{\text{XFLG4}}$ is reserved for requesting the 440 to read in upper or lower front panel commands on the XD input bus.

$\overline{\text{XFLG2}}$, when low, commands the 440 to inhibit the normal slew rate limiting time out used when in the X-Y PLOT mode. Plotters driven at a uniform rate on their time axis require uniformly spaced output data on their vertical axis. In addition, the X-Y PLOT mode may be used to output digital or analog data at the uniform plotting speed to devices that do not have slew rate limiting.

$\overline{\text{XFLG3}}$, when low, will force the 440 to analyze, display, and output spectrum data starting at the 41st frequency cell, i.e., ten percent of the applicable FREQUENCY RANGE, through the 440th cell, or ten percent above the upper frequency of the FREQUENCY RANGE. This ten percent shift is used when the input signal to the 440 is derived from a Range Translator. The band-passed signal translated to the origin is aliased by the negative image in the frequency domain of that same translated signal due to the non-ideal finite slope of the bandpass filter cutoff characteristic. Note that the cursor position reading will not be affected when operating in the translation mode.

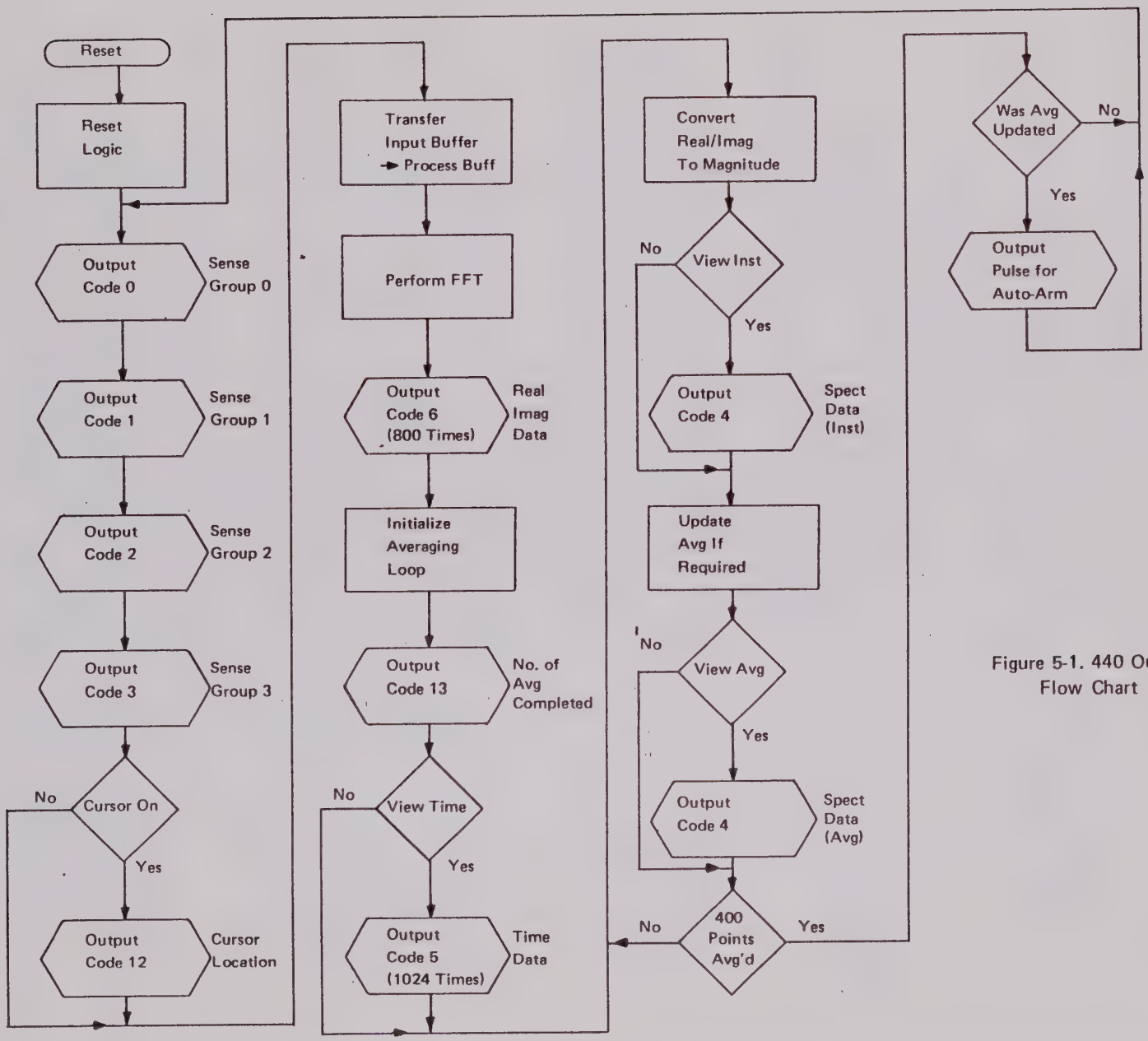


Figure 5-1. 440 Output Flow Chart

SECTION VI

MODEL 440 BLOCK DIAGRAM DESCRIPTION

6-1. Scope of This Section

This section will present a block diagram description of the 440 system and will provide a breakdown of each block with regard to its function and physical board location.

6-2. Organization of the 440

The 440 is organized so that the -10 plug-in unit performs all the necessary analog signal conditioning and digitizing of the input signal prior to actual system processing. Six small printed circuit boards comprise the basic -10 plug-in unit and these boards will be described in further detail below.

Digital signal processing, display control, and front panel interfacing is performed on three large wire-wrap boards located in the mainframe of the 440. The digital signal processing section accepts its input data from the -10 plug-in unit's analog-to-digital converter and provides two output busses, i.e., the horizontal and vertical busses, as well as Z-axis and mode control signals to the system's display board.

The function of the system display is to convert the processor's output busses into corresponding analog signals to drive the corresponding deflection plates of the system display CRT. In addition, the display system, under the processor's control will gate the display on or off, and will scale deflection voltages according to mode commands received. The display system also provides the system's pen output, buffered horizontal and vertical outputs, and accepts external deflection voltages for alternatively displaying signals from a remote input.

6-3. Basic Block Diagram Description (Figure 6-1)

Data applied to the system's input is attenuated under operator control, lowpass filtered so that its frequency response cuts off sharply at the band edge selected by the FREQUENCY RANGE control, and then digitized in the analog-to-digital converter. Each digitized input sample is placed into a successive location in the 1024 word input buffer. Note that unless

the system is placed into a HOLD mode, or sampling is interrupted, this process is a continuous one. Consequently, every new input sample will overwrite, or replace, the input sample that was collected 1024 sampling intervals earlier. Input data collection is virtually independent of system control.

A block indicated in Figure 6-1 as MULTIPLEXER shows four inputs and one output. One of these inputs is the data output from the input buffer. Another input is the output bus from the system's microprocessor. The two other inputs are provided by the output from the system's active memory bank and a remote source, respectively. Although shown as a single input line, it is important to remember that each of the lines represent one or more busses.

The block indicated as MICROPROCESSOR actually consists of a number of separate block funtions, which will be described in greater detail. At this point, however, it is important to realize that the MICROPROCESSOR is the controlling element of the 440 system. The MICROPROCESSOR is programmed to sequence through a predetermined number of steps, at each step performing either a group of control functions, arithmetic computations, or data manipulations, or combinations of these operations.

The MICROPROCESSOR determines which input bus to the MULTIPLEXER will appear at its output and whether that bus will be entered into one of its random memory locations or undergo logic or arithmetic manipulation with any of the MICROPROCESSOR's internal busses.

The sequence of steps through which the MICROPROCESSOR progresses is dictated by a program stored within the MICROPROCESSOR itself. After the MICROPROCESSOR has sequenced through the required number of steps, the original data block of 1024 data samples will have undergone transformation from the time to the frequency domain.

Further data manipulation by the MICROPROCESSOR averages spectra and stores the averaged spectrum in one of its internal active memory banks.

The MICROPROCESSOR interrupts processing on a periodic basis to refresh the display with the most recent data to be presented, as well as to redraw the graticule and various annotation data.

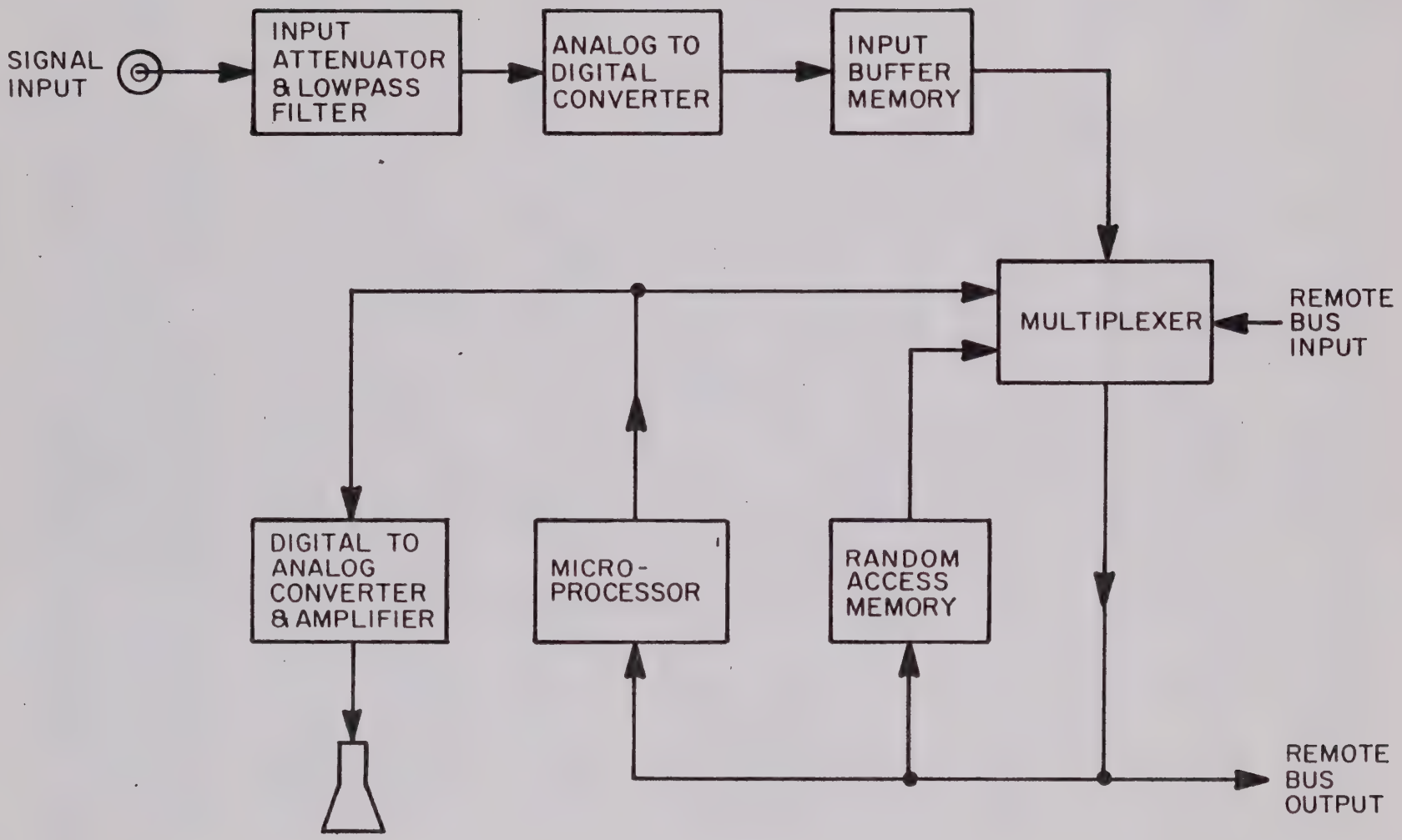


FIGURE 6-1. 440 BASIC BLOCK DIAGRAM

Almost all front panel controls are read by the MICROPROCESSOR and echoed back to the appropriate point in the system where they are to be used.

Input and output interface control is exercised by the MICROPROCESSOR and communicated via the input and output busses available at the rear panel connectors of the unit.

6-4. Plug-In Board Description and System Block Diagram (Figure 6-2)

A. The following discussion will describe the -10 plug-in boards in detail and their function within the system. (The numbers correspond to the numbers in Figure 6-2.)

1. INPUT ATTENUATOR - The inputs to this board are the INPUT SIGNAL from the front panel INPUT SIGNAL BNC or the TEST SIGNAL generated on the SAMPLING CONTROL board. Under front panel control, one of these signals is selected and applied to a compensated step attenuator network, controlled by COARSE INPUT AMPLITUDE controls on the front panel. The output of this network is buffered and amplified in a stage controlled by the FINE INPUT AMPLITUDE control on the front panel. Note that the FINE INPUT AMPLITUDE control is exercised only through the front panel and cannot be exercised from a remote source.

The INPUT ATTENUATOR also contains the shaping circuit required for the ORDER CONTROL SAMPLING INPUT signal so that a wide range of input levels and waveforms can be accommodated for external sampling.

2 and 3. FILTER NO. 1 - FILTER NO. 2 - These two boards accept the output signal from the INPUT ATTENUATOR and pass the signal through a buffer stage, a 9-stage 7-pole, elliptic, active filter, and a final gain and offset stage. All passive components used in these stages to determine frequency characteristics of the filter, are controlled by the FREQUENCY RANGE controls, or when remotely controlled by external commands.

4. A/D CONVERTER - This board receives the lowpass filtered signal from FILTER 2 board, samples and holds the signal at the sampling clock rate, performs a successive approximation of the sampled signal, and provides a parallel 11-bit digital word at the end of each analog-to-digital conversion cycle. This bus is tri-stated with the external input bus and directly applied to the input buffer.

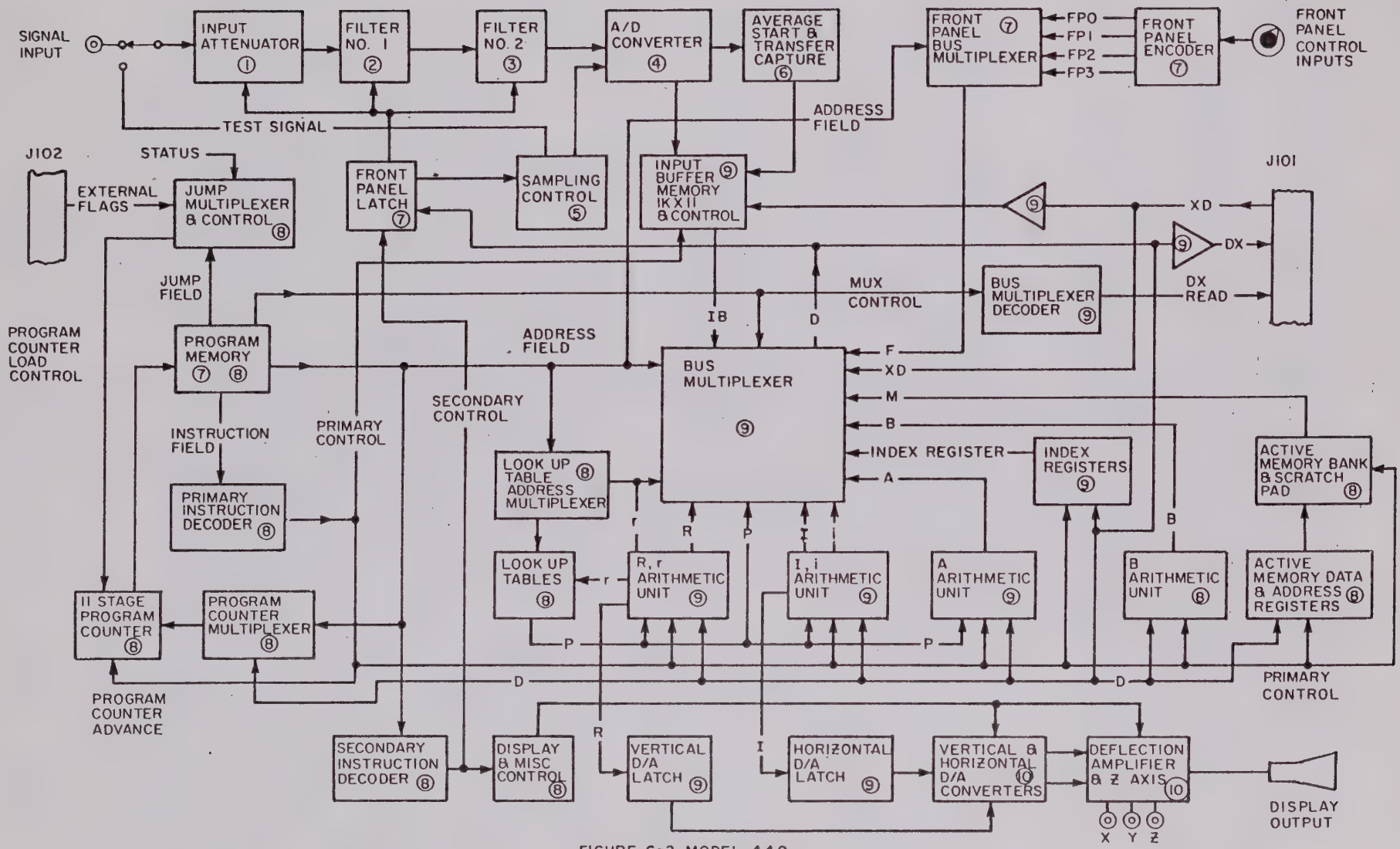


FIGURE 6-2 MODEL 440
SYSTEM BLOCK DIAGRAM

5. SAMPLING CONTROL - This board contains the crystal oscillator and countdown circuits which generate the internal sampling frequency pulses required for the various frequency ranges selectable at the front panel. The system Test Signal is also generated on this board. This signal has a fundamental frequency equal to 64 percent of the selected FREQUENCY RANGE and will appear at 64 percent of the sweep when the internal sampling mode of operation is selected. A two millisecond clock signal is also provided by this board to the system which is subsequently counted down to the real time clock frequency of the 440 system.

6. AVERAGER START AND TRANSIENT CAPTURE - The functions of this board are to generate gated end-of-conversion pulses to the write control portion of the system, to generate averager enable flags based on the input data blocks, and to regulate the HOLD operation through either manual control, or signal threshold crossing when the system has been placed in the ARMED position.

Averager start pulses are generated when either a full block of 1024 words have been entered into the input buffer memory in the external block sync mode, or whenever 512 words have been collected in the continuous sampling mode. The 512 word, 50 percent redundancy mode, permits faster averaging at the expense of some data overlap.

Digital data processed by the system is derived from either an external source (internal A/D enable signal is low) or an internal source (internal A/D enable signal is high). Gated end-of-conversion pulses are derived from the delayed internal or external sampling clock. These pulses may be gated off in either of these modes whenever a full block of 1024 words are collected, if the control signal $\overline{\text{STOP ON FULL}}$ is activated in the low state. End-of-conversion pulses are also gated off whenever the HOLD is activated or whenever the system has been ARMED and the signal threshold commanded by the TRIG LEVEL control is exceeded.

The block sync pulses accepted by this board and the status flip-flop $\overline{\text{BUFFER FULL}}$ serve to delineate blocks of 1024 words when used in conjunction with an external data source and external end-of-conversion pulses.

Other output signals from this board include the drive signals for the front panel: ARMED, HOLDING, OVERLOAD, and AMPLITUDE indicators.

6-5. Mainframe Board Description and System Block Diagram (Figure 6-2)

A. The following discussion will describe the functions and interactions of the three large system boards with respect to the presentation of the block diagram in Figure 6-2.

7. ENCODER - This board contains the interface between the front panel and the system Microprocessor. Front panel switch contacts are encoded and assembled into four processor words. At any point in the program, a secondary instruction may be issued which will select one of these four data words and permit it to appear at the output of the Bus Multiplexer. In this manner, the Microprocessor is able to read the entire front panel status in a sequence of four secondary instructions. The meaning of the term "secondary instruction" will be explained below.

The Microprocessor echoes front panel settings back to the corresponding control circuits, where necessary, by placing the matching data word on the common "D" bus through one of the other inputs to the Bus Multiplexer. Again, under secondary instruction control, the "D" bus is clocked into the front panel latch which in turn exercises control over such operations as COARSE INPUT AMPLITUDE, TEST/INPUT SIGNAL, FREQUENCY RANGE, and FREQ/ORDERS. If the 440 is commanded to control the lower front panel from a remote source, signified by the assertion of the external flag 1 and external flag 4 signals at rear panel connector J102, the "D" bus that is returned by the Microprocessor into the front panel latch will reflect a command that was applied by the remote source on the external input bus, and will not be an echo of the corresponding front panel bus.

The ENCODER also includes special debouncing and synchronizing circuits for front panel switch contacts, where required. In addition, the system's Program Memory is located on the ENCODER and this block will be described in conjunction with the PROGRAM CONTROL board below.

8. PROGRAM CONTROL - This PROGRAM CONTROL board includes the Program Counter, Primary and Secondary Instruction

Decoders, Jump Multiplexer, Random Access Memory Banks and Data Registers, Look-Up Tables, and the "B" Arithmetic Unit. These units will now be explained:

a. Program Counter - The Program Counter determines the sequence of instructions that are executed in the system by generating sequential instruction addresses to the Program Memory. The counter can either step by an increment of one, which occurs when no special jump decision is made by the program, or can be loaded with a value determined by the current instruction itself. This value may be either a "literal" value, i.e., one that is directly derived from a portion of the instruction word, or from the system "D" bus. Recall that this is the common output bus from the Bus Multiplexer. The selection of input bus to appear at the output of the multiplexer is, of course, also executed by the current instruction word.

b. Program Memory - The Program Memory consists of groups of ROM's (Read Only Memories) which are addressed by the Program Counter to provide the instruction words that sequence the 440 system through its operations. Each instruction word is broken into eight fields, as follows:

Four fields are used to provide four independent instructions to four groups of arithmetic units within the system.

One field is used to independently address the system's "scratch pad" memory.

One field is coded to activate the jump operation upon detection of a system status assigned to that code.

One field is coded to select one input bus to the Bus Multiplexer to appear at the multiplexer output, i.e., the "D" bus.

The eighth field contains the address to be loaded into the Program counter upon detection of a jump status condition. If an unconditional "no jump" is commanded, this field is used to address various Look-Up Tables used by the 440 system. If the "no jump" command condition is true, and only a limited portion of this field is needed for a Look-Up Table, then the remaining portion of this field is used as a set of secondary instruction codes.

c. Primary Instruction Decoder - The four fields containing four separate instruction words to the various arithmetic units within the Microprocessor portion of the system are binary coded for maximum efficiency. To translate these

coded instruction words into corresponding hardware control signals, the Primary Instruction Decoder is used. Note that the four fields comprise the primary instruction portion of the entire word because these fields are dedicated to arithmetic instruction and multi-control. In contrast, the secondary instruction portion of the entire instruction word is shared with the address function of the same field, and generally yields only a single control function at any given time.

d. Secondary Instruction Decoder - This block of hardware decodes the secondary instuction portion of the address field (the eighth field described above) and generates a unique control function for any given code. As noted above, secondary instructions are inactive if a jump condition is tested or if the full address field is dedicated to a lookup operation.

e. Look-Up Tables - These tables contain all the necessary constants and conversions, e.g., logarithms and anti-logarithms, as well as alpha-numeric coded character images, for reference by the main program.

f. Look-Up Address Multiplexer - The Look-Up Tables may be addressed directly by the address field of the instruction word or by a specific system register output (the "r" bus shown in the block diagram) such as would be required when the address is data dependent. The Look-Up Address Multiplexer selects the appropriate bus and this selection in turn is controlled by the high order bits of the address field.

g. "B" Arithmetic Unit - This arithmetic unit is configured to efficiently implement address manipulation used in the processing algorithms of the Fast Fourier Transform.

h. Display and Miscellaneous Control - This hardware includes all the Microprocessor I/O controls to the Display section of the 440 system, e.g., logarithmic scale, plot mode, intensity axis gate, as well as certain controls used by the Microprocessor itself. The latter includes the acknowledgment of the real time clock, program flags, reset of hardware flags, control of the front panel IN PROCESS indicator, and loading of the Front Panel Latch. Also included in this block are various controls required for the operation of output devices, such as the Tektronix 613/611 Storage Oscilloscope. Note that the inputs to this block are the outputs from the Secondary Instruction Decoder.

i. Active Memory, Data and Address Registers - These registers contain the data and the address values to be used in conjuntion with a selected memory from the active memory bank. The inputs to both these registers are provided by the system "D" bus.

j. Active Memory Bank and Scratch Pad - The active memory is made up of three memory groups:

(1) Processor Memory
(2) Averager Memory
(3) Display Buffer

The Processor Memory stores the input array of sampled data and successive transformations of this data into an array of frequency elements. The complex spectrum is derived from this memory after the final transformation process.

The Averager Memory stores the accumulated values of successive power spectra when the averaging mode is enabled. The method of accumulation is, of course, determined by the front panel SPECTRUM AVERAGE mode controls.

The Display Buffer is used to store the 400 spectral values appearing on a frequency display. Note that time data passes directly from the input buffer to the display and does not get buffered in the Display Buffer. Data store in the Display Buffer is formatted prior to entry into the buffer.

9. ARITHMETIC UNIT - The ARITHMETIC UNIT board contains a number of different arithmetic units, some of which are internally cross-coupled and all of which are connected to the system "D" bus at their input and contribute to the "D" bus via the Bus Multiplexer at their output. The ARITHMETIC UNIT also includes the Input Buffer Memory and Control, the Vertical and Horizontal D/A Latches, and Index Registers for general control, as well as the Bus Multiplexer. These blocks will be described in the paragraphs that follow:

a. "R,r" Arithmetic Unit - This arithmetic unit contains two extensive registers, corresponding arithmetic logic units, and additional multiplexing and control. It is used, in conjunction with the "I,i" Arithmetic Unit to perform FFT data processing, as well as the bulk of display, averaging, and

control processing. This arithmetic unit has direct access to the output of the Look-Up Tables, i.e., the "P" bus, and the output of the "I,i" Arithmetic Unit, as well as the system's common "D" bus.

b. "I,i" Arithmetic Unit - This arithmetic unit is structured identical to the "R,r" Arithmetic Unit and shares the bulk of system processing with that unit. Note that both these arithmetic units are controlled by a common instruction field; however, the resultant decoded instruction to these arithmetic units generally represents two different operations for the two units.

c. "A" Arithmetic Unit - This is an auxiliary arithmetic unit primarily intended for angle accumulation in the FFT algorithm but used in various portions of the program where its use is required.

d. Index Registers - A set of two independent index registers are available for program use as delay or time-out elements. Their carry outputs are capable of being sensed and are generally used in a conditional jump operation.

e. Vertical and Horizontal D/A Latches - Data that is ready for transfer to the Display Subsystem is entered into these latches directly from the outputs of the "R,r" and the "I,i" Arithmetic Units. Loading of these latches is, of course, controlled by the program and occurs only during the display portion of the program.

f. Input Buffer Memory and Control - Data from the A/D Converter, or data from an external source when selected, is entered into a 1024 word buffer memory. Writing into this memory occurs at the data sampling rate and is essentially independent of program control. However, reading of data from this memory is entirely under program control and must be distinct in time from the write operation. Consequently, writing into the memory will be inhibited during a read operation and will be executed immediately thereafter if a write request is present. As shown on the block diagram, data read from this memory is one of the inputs to the Bus Multiplexer and appears on the "D" bus when selected by the program.

g. Bus Multiplexer - This multiplexer includes every major bus output from an arithmetic or memory unit, as well as front panel multiplexed bus, address-field literal data, and the Look-Up Table "P" bus output. The control of the Bus Multiplexer is derived from a separate field in the instruction word and, although not shown on the block diagram, may be overridden by external select commands.

h. Bus Multiplexer Decoder - Data appearing on the "D" bus also appears on the buffered "DX" bus at the J101 rear panel connector. However, only certain types of data are significant for an external device; consequently, it is necessary to provide a read strobe and an identification code on the bus itself to alert the external device to the type of data currently on the bus. Whenever the 440 provides output data, a restricted code is used to select one of the inputs to the multiplexer. Upon detection of this code, the Bus Multiplexer generates a DX READ strobe, nominally two microseconds in duration during which time data remains stable on the "XD" bus. The coded portion of the "DX" data may be examined during the time DX READ is asserted and the device may either reject or accept the current data frame depending on the detected code.

10. DISPLAY BOARD - The DISPLAY BOARD contains the Vertical and Horizontal Digital-to-Analog Converters and the corresponding low and high voltage Deflection Amplifiers, as well as Z-axis level translators, plot control circuits, coordinate rotation controls, gain and offset controls, and external horizontal and vertical input buffers for displaying analog data from an external source on the 440 CRT.

SECTION VII

USER ADJUSTMENTS

7-1. Scope of This Section

This section of the instruction manual provides the user with the necessary information for adjusting certain system controls without the need to introduce special test equipment. Controls other than those provided for customer use will be included in this section for information only. These controls have been preset at the factory and should not be readjusted without prior consultation with Nicolet's Service Department.

7-2. Input Offset Adjustments

A. AC Coupling:

Set the following switches to their indicated positions:

TEST/AC/DC	to AC
VIEW	to TIME
ANNOTATION	to FULL
FREQ/ORDERS	to FREQ
HOLD/REL	to REL
INPUT SIGNAL	none

The display should consist of a horizontal line aligned with the fifth vertical tic mark. If this line is not on the fifth tic mark, adjust potentiometer R1 (20,000 ohms) on the AD CONVERTER for proper alignment.

B. DC Coupling:

Set the TEST/AC/DC switch to DC. All other settings should remain as in paragraph A. above.

Set INPUT AMPLITUDE COARSE and FINE controls to their maximum clockwise positions, i.e., 0 dB, and ground the INPUT SIGNAL BNC.

Again the display should consist of a single horizontal line at the fifth vertical tic mark. If this is not so, two controls may be adjusted for centering the line.

On the INPUT ATTENUATOR card adjust potentiometer R1 (1000 ohms) for proper centering of the horizontal line.

If there is insufficient range in this adjustment, potentiometer R15 (20,000 ohms) on FILTER NO. 2 may be adjusted to complete the centering alignment.

7-3. Input Gain Adjustment

Set the following switches to their indicated positions:

TEST/AC/DC	to AC
INPUT AMPLITUDE	to 0 dB (COARSE and FINE)

Apply a sinusoidal INPUT SIGNAL at a frequency of 1 percent of selected FREQUENCY RANGE and at an amplitude of 280 mv peak to peak (100 mv rms).

Set the VIEW switch to TIME and verify that the displayed signal is at the threshold of clipping at both top and bottom extremes. If not, adjust potentiometer R2 (20,000 ohms) on the A/D Converter until clipping occurs. If clipping is not symmetrical, it may be necessary to readjust the AC offset control outlined in paragraph 7-2, A., above, and then repeat the gain adjustment. After symmetrical clipping is achieved, no further offset adjustment should be made, although exact centering may have been slightly affected in the gain adjustment procedure.

7-4. A/D Converter Adjustments

The following potentiometers on the A/D Converter are used to adjust the relative weights of A/D Converter bits. They are listed below for information only and should not be adjusted without prior consultation with Nicolet Scientific Corp.

Control	Function
R3	Correct weight for 1/2 MSB
R4	1/4
R5	1/8
R6	1/16
R7	Correct weight for the sum of all succeeding lower bits, equal to 1/32 MSB.

7-5. Display Adjustments

Unless otherwise noted, all display adjustment controls are located on the Display Circuit board. (See Figure 7-1.) Extreme caution should be used when servicing the Model 440 with any of its side panels removed. Lethal voltages exist within this unit. The Display Circuit controls should always be adjusted through the holes provided on the protective plexiglass cover. Removal of this cover with power applied to the unit should be attempted by trained personnel only. All adjustments made by the user are to be made to achieve the optimum result based on the function of that control only. In general, optimum results are observed on a working display with the FULL ANNOTATION on.

1. FOCUS - This control is mounted in a small enclosure on the frame behind the Display Circuit board. This control is adjusted to achieve optimum definition of both horizontal and vertical lines on the display. The control will generally interact with the ASTIGMATISM control and should be adjusted under normal screen intensity setting.

2. INTENSITY - This control is located directly below the FOCUS control. The adjustment may be made to suit the viewer for ambient lighting conditions; however, excessive brightness makes FOCUS adjustment more difficult and may shorten the life of the CRT.

3. R19, ASTIGMATISM - Adjust this control for equal focus of horizontal and vertical lines. Readjust FOCUS if necessary.

4. R20, PATTERN CORRECTION - Adjust this control for minimum bowing of the vertical graticule lines. Check corners

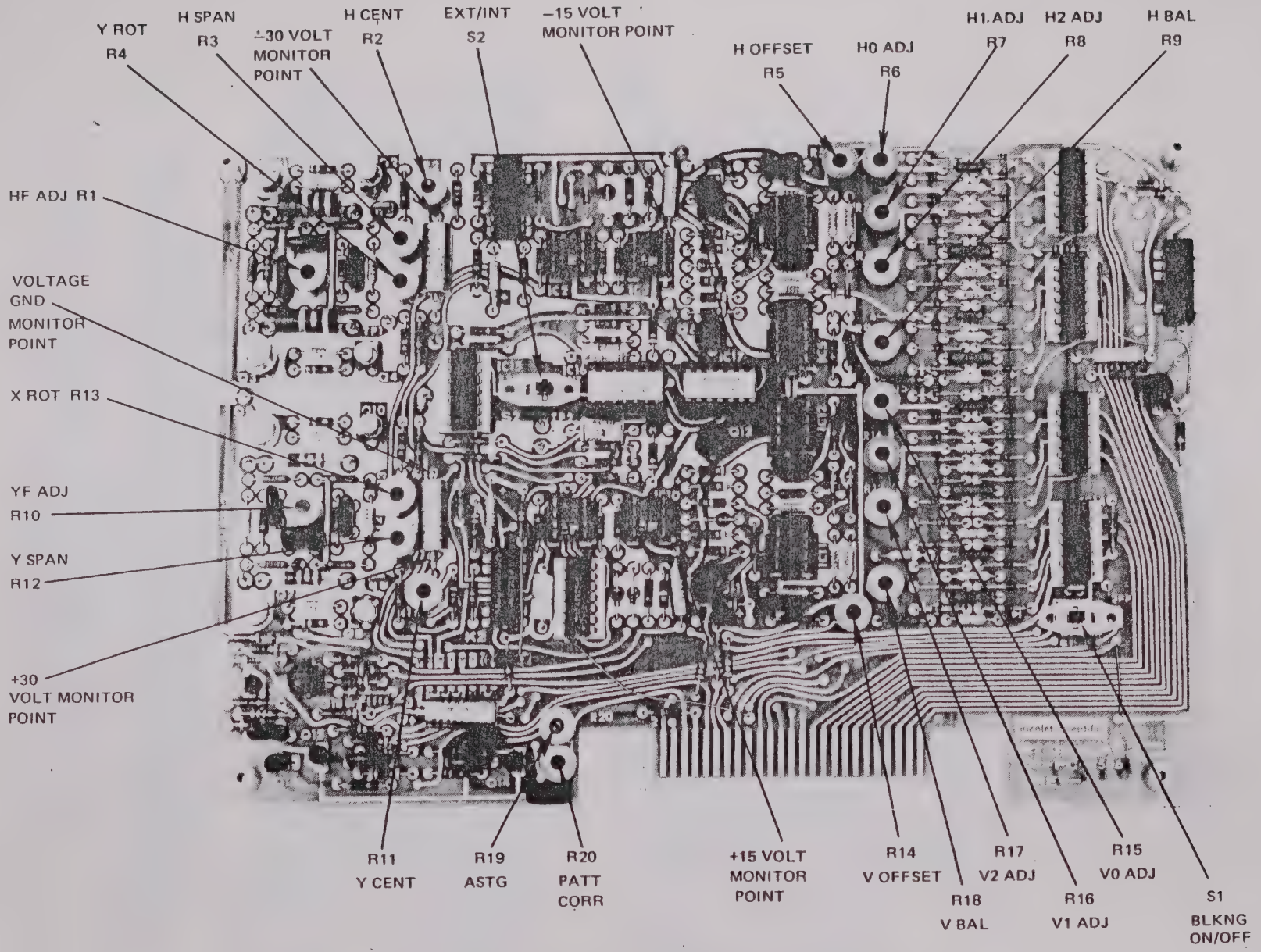


Figure 7-1. Display Board Adjustment Locations

of the graticule for optimum alignment with horizontal graticule lines. This control will generally interact with the ASTIGMATISM control.

5. R4, Y ROTATE and R13, X ROTATE - These controls are adjusted to achieve a graticule whose vertical and horizontal lines are perpendicular to each other and parallel to the vertical and horizontal edges of the CRT, respectively. Both controls will generally have to be adjusted simultaneously.

6. R10, VF ADJUST and R1, HF ADJUST - These controls affect the high frequency compensation of the two deflection amplifiers. Their effect can best be observed at the graticule corners. Adjust these controls so that at the corners of the graticule, the horizontal and vertical lines meet with minimum change in slope and intensity, and with minimum overshoot.

7. R11, Y CENTERING and R2, X CENTERING - These controls may be used to obtain a pattern optimally positioned vertically and horizontally on the CRT. Note that if the V OFFSET or H OFFSET controls are subsequently adjusted for minimum offset on the Y OUT or X OUT signals, the corresponding CENTERING controls may require readjustment for optimum centering on the CRT.

8. R3, H SPAN; R12, Y SPAN - These controls are used to control the gain in the horizontal and vertical axis.

9. R14, V OFFSET; R5, H OFFSET - These controls are normally factory preset so that an all zero digital word into the D/A Converters will produce an analog output of 0 volts at the Y OUT and X OUT BNCs. However, if for any reason, the user wishes to readjust these controls to suit his needs, he may do so by displaying the outputs on his X-Y oscilloscope and adjusting these controls for optimum centering. It will then be necessary to readjust the Y CENTERING or X CENTERING control for local CRT display centering since the offset added by the first adjustment is also in the main signal path.

10. The following controls are listed for information only. Do not attempt to adjust them unless you have contacted Nicolet's Service Department and are convinced that readjustment is necessary.

Control	Function
R15	V0 ADJUST, Correct weight for MSB
R16	V1 ADJUST, 1/2 MSB
R17	V2 ADJUST, 1/4 MSB
R18	VBalance, sum of V5 through V10 = 1/32 MSB
R6	H0 ADJUST, Correct weight for MSB
R7	H1 ADJUST, 1/2 MSB
R8	H2 ADJUST, 1/4 MSB
R9	HBALANCE, sum of H5 through H10 = 1/32 MSB

7-6. Power Supply

A. Description

This power supply convertor employs the switching type inductor storage design. The unit is capable of delivering a regulated +5 volt output and unregulated +20, -20, +40, -40, and +225 volt outputs. The regulated +5 volt supply is adjustable between 4.50 volt to 6.25 volt at the output connector. In addition, the convertor has an inherent self-protecting power-limiting capability.

The unregulated outputs are regulated by the regulator board to provide regulated +15, -15, +30, -30 and +175 volt outputs. In addition, this supply includes a high voltage convertor section which generates the +1500, -1500, and 6.3 volt output for the cathode ray tube power requirements.

All the voltages have a common floating ground at the output of the main power convertor. Table 7-1 summarizes the output voltages and maximum currents from the supply.

Table 7-1. Power Supply Outputs

Voltage (Volts DC)	Maximum Current (Ampere DC)
+5.2	14
+15	1
-15	1
+30	0.1
-30	0.1
+175	0.02
+1500	20 na
-1500	20 na
-900	20 na
6.5 (AC)	0.3 (AC rms)
+38 unregulated	

B. Convertor Block Diagram

Figure 7-2 is a simplified block diagram of the main power convertor. It consists of five major elements.

a. Line EMI Filter, Rectifier and Filter
b. Oscillator
c. Drivers and Switches
d. Transformers, Rectifier, and Filters
e. Feedback Amplifier and Isolator.

C. Theory of Operation

Line voltage is passed through an Electro-Magnetic Interference filter. This is to prevent high frequency noise generated in the convertor from being fed back into the line, and line noises from entering the system through the power supply.

The AC line voltage is then fed to the rectifier circuits. This circuit consists of a voltage doubler and filter for 110V AC input or a full wave rectifier and filter for 220V AC input. This rectified voltage (V+) is the main operating voltage for the convertor, and is between 250V DC and 350V DC.

During initial start-up condition, the oscillator obtains its operation voltage (B+) from V+ through a 5 volt series regulator. Once normal operating conditions are established the oscillator utilizes one of the main transformer outputs. The start-up operating voltage of B+ is 5 volts and the normal operating voltage of B+ is between 8 to 15 volts.

At 5 volts, the oscillator will operate as bistable oscillator with fixed frequency and duty cycle. At voltages above 5 volts, the oscillator will operate as voltage controlled oscillator with fixed "on" cycle. The controlling voltage is the output of the feedback error amplifier. The output of the oscillator is the switching pre-driver for the driver stages.

There are two identical drivers, each driving an independent switching transistor in series with the transformer. During "on" periods, the transformer will have the characteristics of a pure inductor because all the secondary rectifier diodes are reverse biased. The electrical energy is now stored in the transformer as magnetic energy. As soon as the switch is off, the current feeding through the transformer is temporarily cut off.

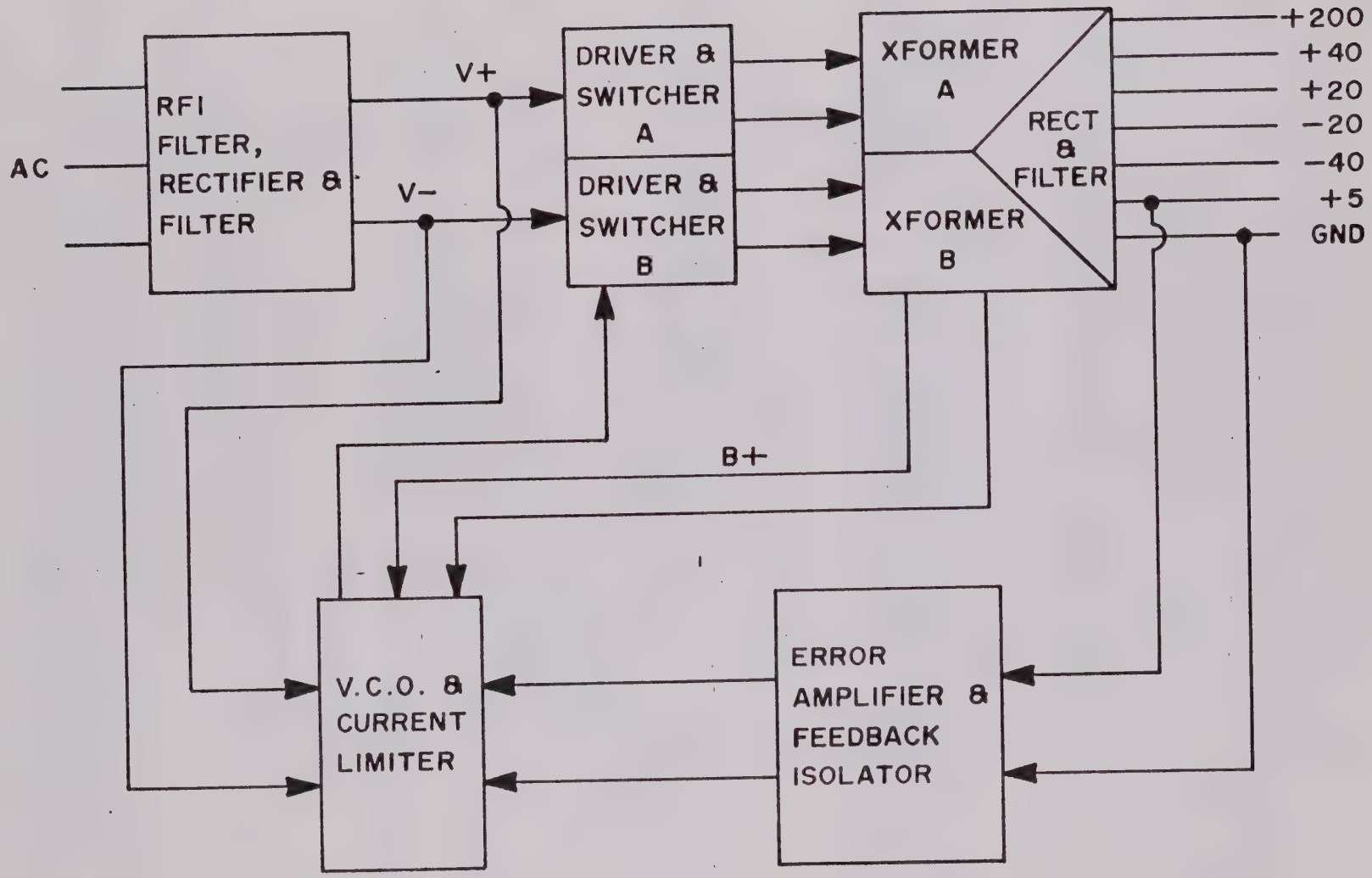


Figure 7-2. Block Diagram for the Model 440 Power Supply

The natural behavior of an electromagnetic circuit is to oppose any sudden change of current in the inductor by trying to maintain an equal but opposite magnetic field. This opposing magnetic field will generate reverse potentials on all the electrical windings of the transformer until the rectifier diodes are forward biased. At that instance, the magnetic energy is transformed into electrical energy, and the secondary circuits will then filter and store the energy to provide a DC output. One of these secondary outputs is the oscillator operating voltage as mentioned earlier.

The controlling feedback circuit operates from the +20 volt output. This circuit will compare the +5 volt output to an adjustable reference voltage, amplify the error and generate a DC level. This level is the controlling voltage to the voltage-controlled oscillator. Isolation is accomplished via an optoisolator.

D. Troubleshooting Procedure

It is recommended that the supply be serviced only by trained personnel. Before attempting to troubleshoot this power supply, confirm that the fault is with the power supply and not with the associated circuits.

Safety Precautions

1. Always use an isolated, variable AC power source for the power supply during troubleshooting.

2. Always remove input power before adding on or removing components from the power supply.

Troubleshooting

Note the mode of failures on the power supply and follow the procedure indicated.

1. All output voltages low (O.V.). See Fig. 7-3.

2. Has +5 volt output, but one or more of the other voltages are low or missing; +5 volt output normal, but one or more of the other outputs are either high or low. This does not include high voltage CRT outputs.

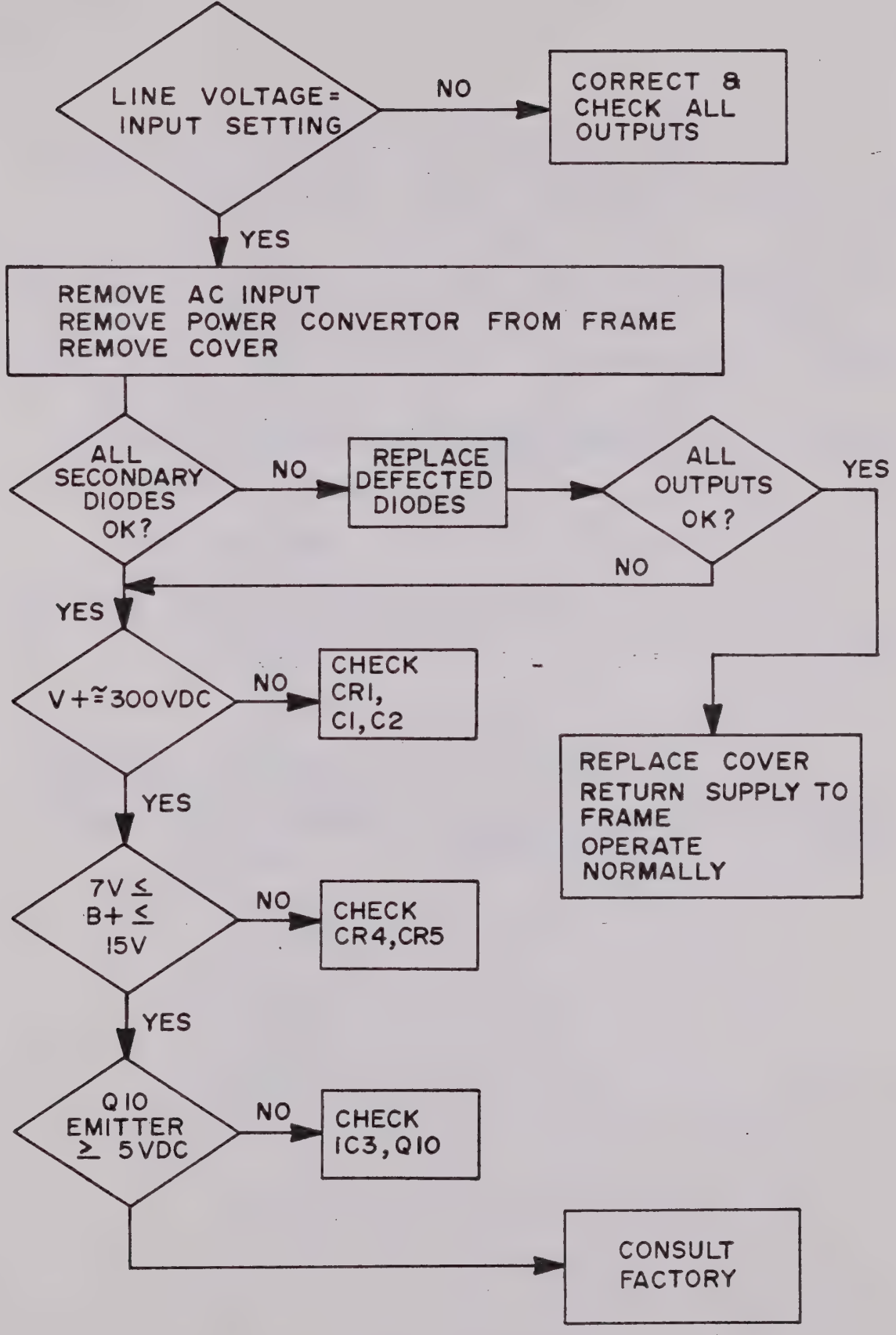


Figure 7-3. All Output Voltages Low

a. Check +15 and -15 output first.

b. If +15 and -15 are normal, then check +30 and -30 outputs. Replace regulator related to the abnormal outputs.

For +175 volt output, if output is high, check the series transistor. If output is low, check the feedback transistor.

WARNING: Do not attempt to troubleshoot high voltage convertor.

3. High ripple on one or more of the outputs. Replace 6.8 uf capacitor from the abnormal output regulator.

4. AC main fuse blown. See Figure 7-4.

5. AC supply fuse blown. See Figure 7-5.

6. Repeated thermal shutdown occurred. Check fan. If fan is running and there is no obstruction to air flow, consult factory.

E. Power Supply Adjustments

There are five adjustments available to the user for setting the systems' operating voltages. Table 7-2 lists the location of the controls, the recommended monitoring points and the correct voltage settings.

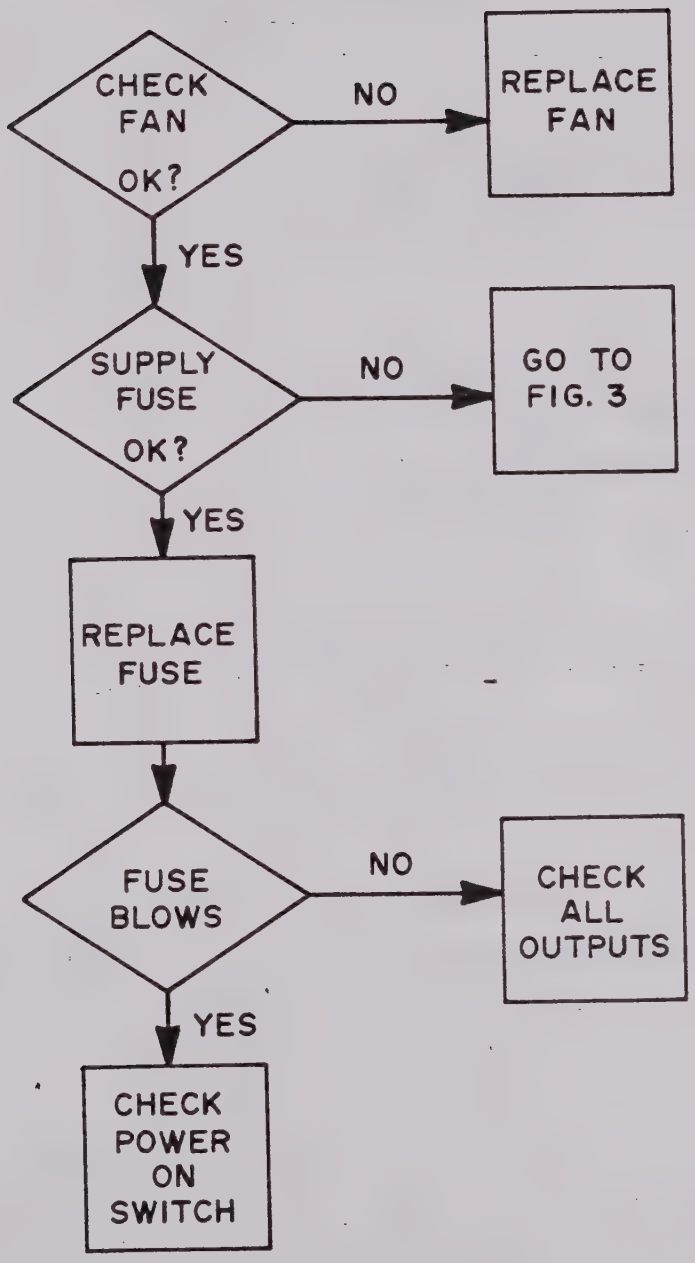


Figure 7-4. AC Main Fuse Blown

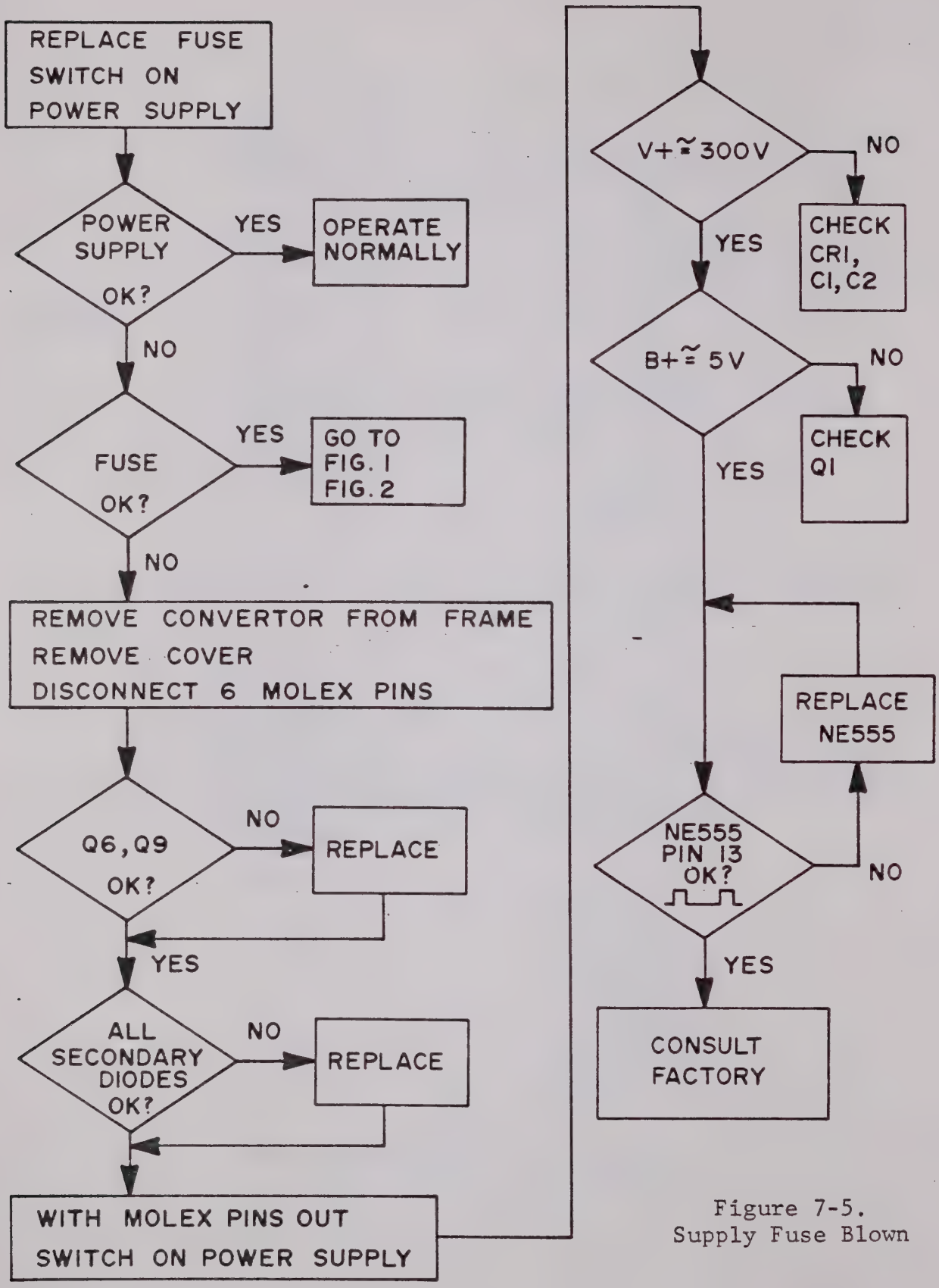


Figure 7-5.
Supply Fuse Blown

Table 7-2
Voltage Adjustments

Voltage/ Control	Adjustment Location	Monitoring Points	Voltage Settings
+5 volts	Rear Panel - Lower Left Corner	a. Program Control Board - Input side of fuse	5.0 volts
		b. Arithmetic Unit Input side of fuse	5.1 volts
		c. Rear Panel - Monitor Point	5.2 volts
+15 volts	See Fig. 7-6	See Fig. 7-1	+15 volts ±100 mv
+30 volts	See Fig. 7-6	See Fig. 7-1	+30 volts ±100 mv
-15 volts	See Fig. 7-6	See Fig. 7-1	-15 volts ±100 mv
-30 volts	See Fig. 7-6	See Fig. 7-1	-30 volts ±100 mv
+175 volts	Not Adjustable		
+1500 volts	Not Adjustable		
-1500 volts	Not Adjustable		
6.3 volts	Not Adjustable		
FOCUS	Refer to Section 7-5		
INTENSITY	Refer to Section 7-5		

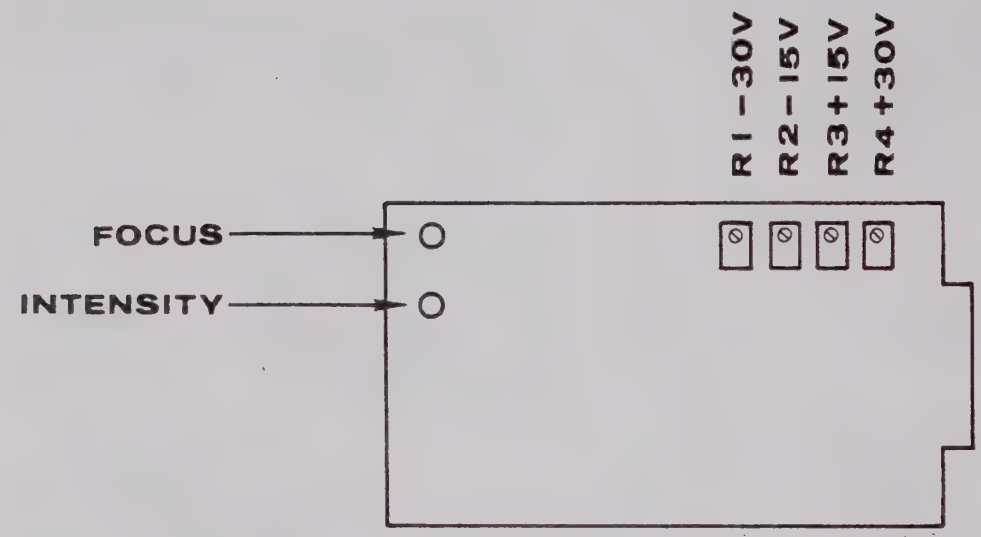


Figure 7-6. ±15, ±30 Volt Adjustment Location

SECTION VIII

-2 EXPANSION PLUG-IN OPTION

8-1. Frequency Expansion Option

This section describes the operating controls, theory of operation, and checkout procedure for the -2 EXPANSION PLUG-IN Option, shown in Figure 8-1, below.

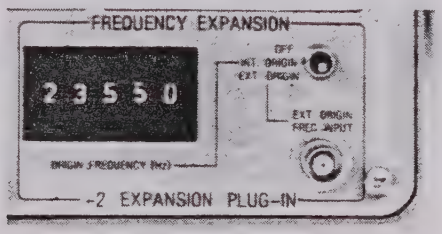


FIGURE 8-1. -2 EXPANSION PLUG-IN

8-2. -2 EXPANSION PLUG-IN Front Panel Controls

A. OFF/INT. ORIGIN/EXT. ORIGIN

1. OFF - This position of the switch bypasses the FREQUENCY EXPANSION function and permits normal operation. In this mode the FREQUENCY RANGE of the analyzer extends from 0 Hz to the maximum frequency indicated by the FREQUENCY RANGE switch.

2. INT. ORIGIN - This switch position enables the FREQUENCY EXPANSION function. In this mode of operation, the frequency axis of the display is expanded to cover a 100-Hz range starting at the frequency set on the ORIGIN FREQUENCY (Hz) digital switch.

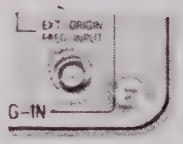
Note

100 Hz is the standard filter bandwidth supplied with the -2 EXPANSION PLUG-IN Option. Bandwidths of 50, 500, 1000, and 2000 Hz are available as options.

The ORIGIN FREQUENCY (Hz) may be varied from 100 Hz (or the optional filter bandwidth) to 99,900 Hz. Although operation is possible with the origin frequency below 100 Hz, spurious signals may be generated which will be visible on the spectrum display. If a spectrum display below 100 Hz is desired, it is advisable to use the standard lowpass ranges of the 440 Spectrum Analyzer.

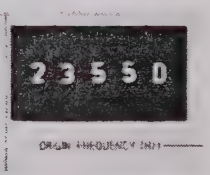
3. EXT. ORIGIN - In this position operation of the frequency expansion function is similar to that described in paragraph 2, above, except that the ORIGIN FREQUENCY is determined by an external frequency reference source, applied to the EXT. ORIGIN FREQ INPUT connector.

B. EXTernal ORIGIN FREQuency INPUT



In the EXT. ORIGIN mode a 1-volt RMS sinusoidal signal applied to this connector will determine the origin frequency. The frequency of the signal applied to this connector is 100 kHz plus the desired origin frequency. The origin frequency is subject to the same limitations outlined in paragraph A-2, above.

C. ORIGIN FREQUENCY (Hz)



The ORIGIN FREQUENCY (Hz) digital switch is used to select the location of the lower frequency edge of the 100 Hz filter bandwidth when the INT. ORIGIN mode of operation is selected. This digital switch may be adjusted in 10-Hz steps from 00000 to 99990 Hz although only the range from 00100 to 99900 should be used.

Note

At certain settings of the ORIGIN FREQUENCY (Hz) switch, an increase in baseline noise (sidebands approximately -35 dB) may be noticed.

8-3. -2 EXPANSION PLUG-IN Checkout

This procedure requires the use of a sinusoidal signal generator (audio oscillator).

A. Set front panel as shown in Figure 4-1 with the following exceptions:

1. TEST/AC/DC in AC.

2. FREQUENCY RANGE in 500 Hz.

3. FREQUENCY EXPANSION/OFF/INT. ORIGIN/EXT. ORIGIN in OFF.

4. CURSOR: OFF

B. Set ANNOTATION switch on rear panel to the FULL position.

C. Apply a 100 mv RMS, 250 Hz sinusoidal signal to the INPUT SIGNAL connector on the front panel.

D. Set the ORIGIN FREQUENCY (Hz) digital switch to 00200 Hz.

E. Observe that the display is as shown in Figure 8-2.

F. Place the FREQUENCY EXPANSION/OFF/INT. ORIGIN/EXT. ORIGIN in the INT. ORIGIN position.

G. Observe the display remains as shown in Figure 8-3, except that Field 2 of the ANNOTATION now reads 100.

Note

If optional filter bandwidth ranges have been installed, then Field 2 should match the range installed.

H. Change the setting of the ORIGIN FREQUENCY (Hz) digital switch to 00160. Observe that the display remains the same except that the spectral line (corresponding to the input signal frequency of 250 Hz) is now located at the ninth tic mark on the horizontal axis.

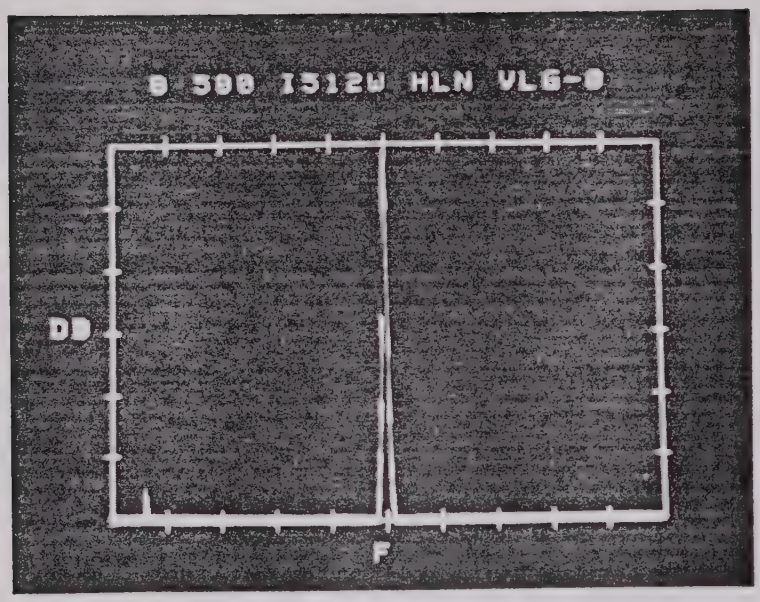


FIGURE 8-2. Refer to Paragraph 8-3E

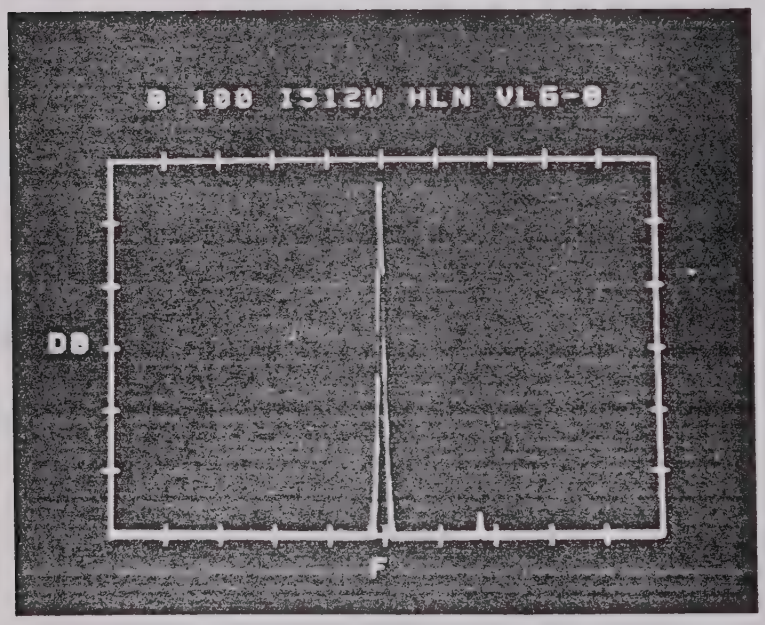


FIGURE 8-3. Refer to Paragraph 8-3G

8-4. -2 EXPANSION PLUG-IN Block Diagram Description

This section presents a block diagram description of the -2 EXPANSION PLUG-IN FREQUENCY EXPANSION circuitry.

When either of the frequency expansion modes (INT. or EXT. ORIGIN) is selected, the input signal is applied through a buffer amplifier to a double balanced mixer (DBM). The origin frequency signal, either from the internal synthesizer or from the external origin frequency source is also applied to the DBM.

The output of the DBM is amplified and drives a lower sideband crystal filter. This filter limits the bandwidth of the input signal to 100 Hz (optional bandwidths of 50, 500, 1000, and 2000 Hz are available). The origin frequency control allows the lower frequency edge of the 100-Hz bandwidth to be moved from 100 Hz to 99900 Hz.

The output of the crystal filter is buffered and is applied to another DBM. In this mixer the filter output is shifted down in frequency until the origin of the 100-Hz bandwidth is 10 Hz. This output is applied directly to the input anti-aliasing filters of the 440 Spectrum Analyzer.

8-5. Changing Filter Bandwidths in the -2 EXPANSION PLUG-IN

The standard filter bandwidth for the -2 EXPANSION PLUG-IN is 100 Hz. Optional filters of 50, 500, 1000, and 2000 Hz are available and may be readily interchanged. The following procedure outlines the steps necessary to interchange Down Converter and Filter Board subassemblies to effect changes in filter bandwidth:

A. Turn OFF the power switch on the Model 440.

B. Unlock and remove the lower front panel drawer. This drawer is connected to the mainframe by a folding cable assembly. Do not remove these cables.

C. Locate the Down Converter and Filter Board Assembly. It is situated in the extreme right-hand position within the drawer directly behind the HOLD/REL pushbutton.

D. Carefully remove the Down Converter and Filter Board from its mounting socket. Disconnect the coaxial cable running between the Down Converter and Filter Board and the Up Cconverter Board.

E. Insert the replacement Down Converter and Filter Board into the proper socket in the drawer assembly. Reconnect the coaxial cable to the Up Converter Board.

F. Check that all boards and connectors are seated securely within the drawer.

G. Replace the drawer assembly into the Model 440 mainframe and secure the drawer lock. This completes the procedure.

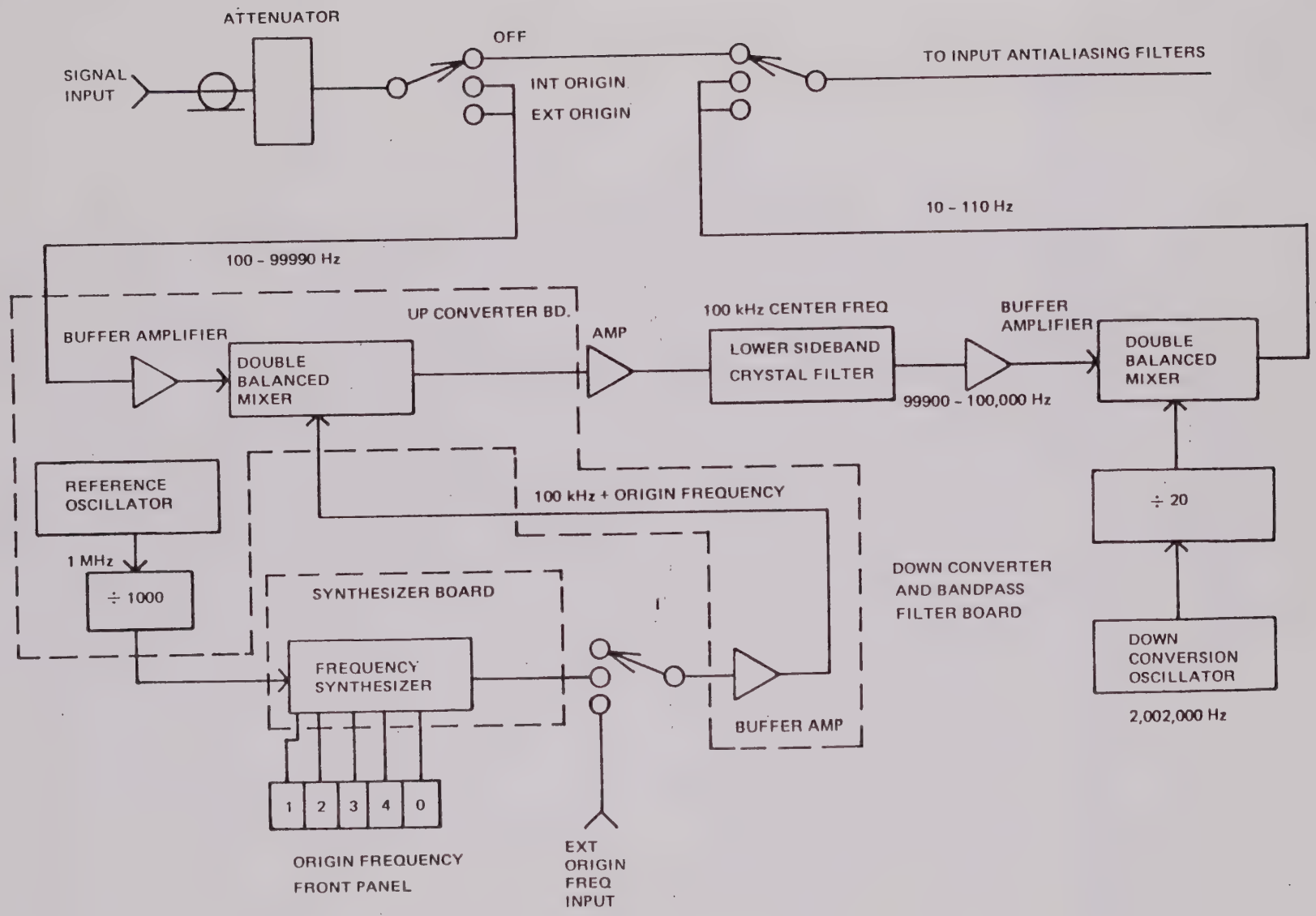
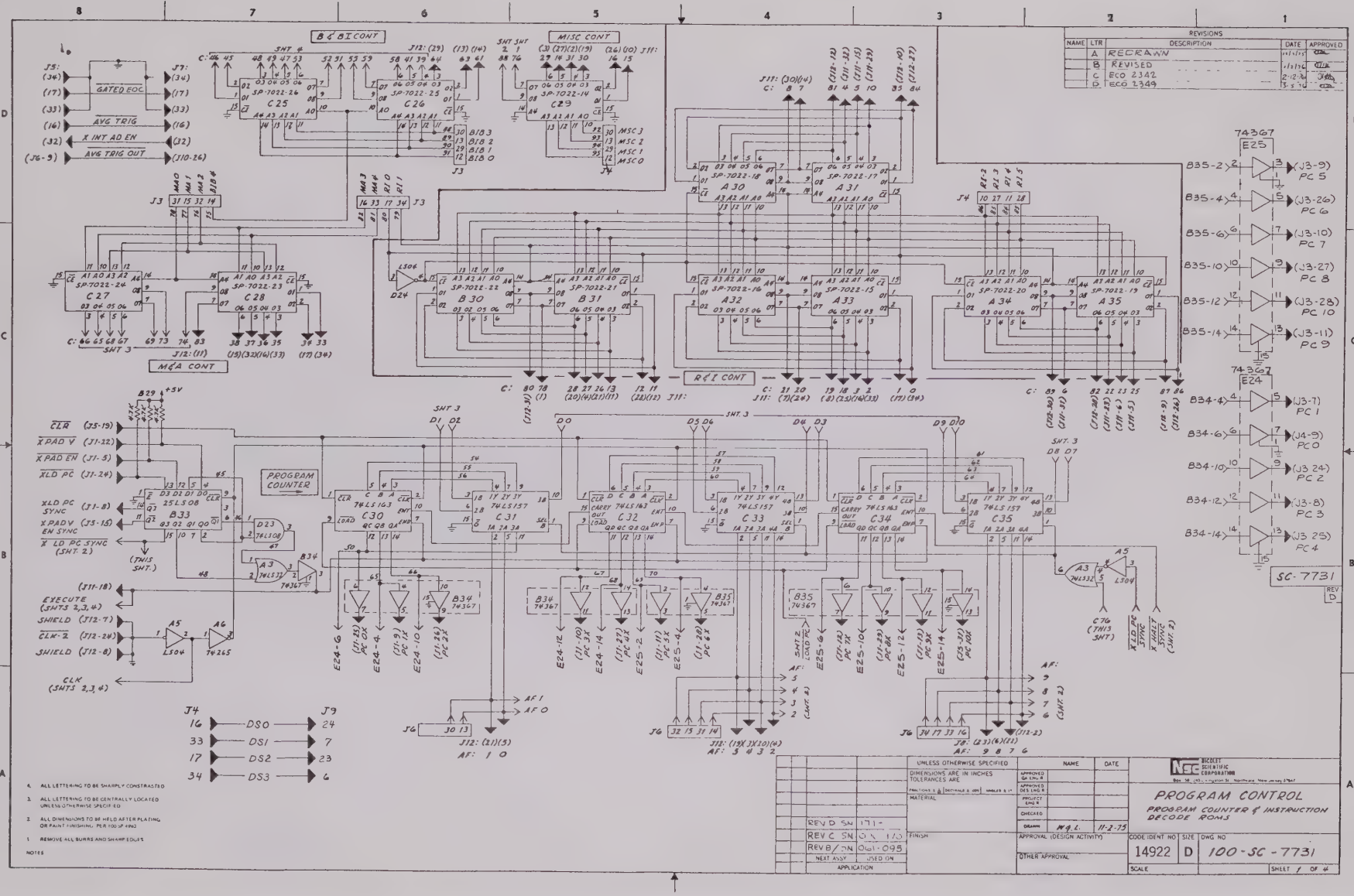


FIGURE 8-4. BLOCK DIAGRAM, -2 EXPANSION PLUG-IN

SECTION X

SCHEMATIC DIAGRAMS

This section of the instruction manual contains the interconnection diagrams, the schematics, and the wiring diagrams for the Model 440.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B REVISED
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D ECO 2349
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MISC CONT
R & I CONT
M & A CONT
PROGRAM COUNTER
GATED EOC
AVG TRIG
X INT AD EN
AVG TRIG OUT
XLD PC SYNC (J1-8)
XPAD V (J1-15)
X LD PC SYNC (SHT. 2)
EXECUTE (SHTS 2,3,4)
SHIELD (J12-7)
CLW-2 (J12-24)
SHIELD (J12-8)
CLK (SHTS 2,3,4)
DS0
DS1
DS2
DS3
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3. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER MIL-P-116
4. REMOVE ALL BURRS AND SHARP EDGES
UNLESS OTHERWISE SPECIFIED
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TOLERANCES ARE
MATERIAL
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REV C SN 001 170
REV B/DN 061-095
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USED ON
APPLICATION
NAME | DATE
APPROVED
APPROVED
PROJECT ENG
CHECKED
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OTHER APPROVAL
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SCALE
SHEET 1 OF 4
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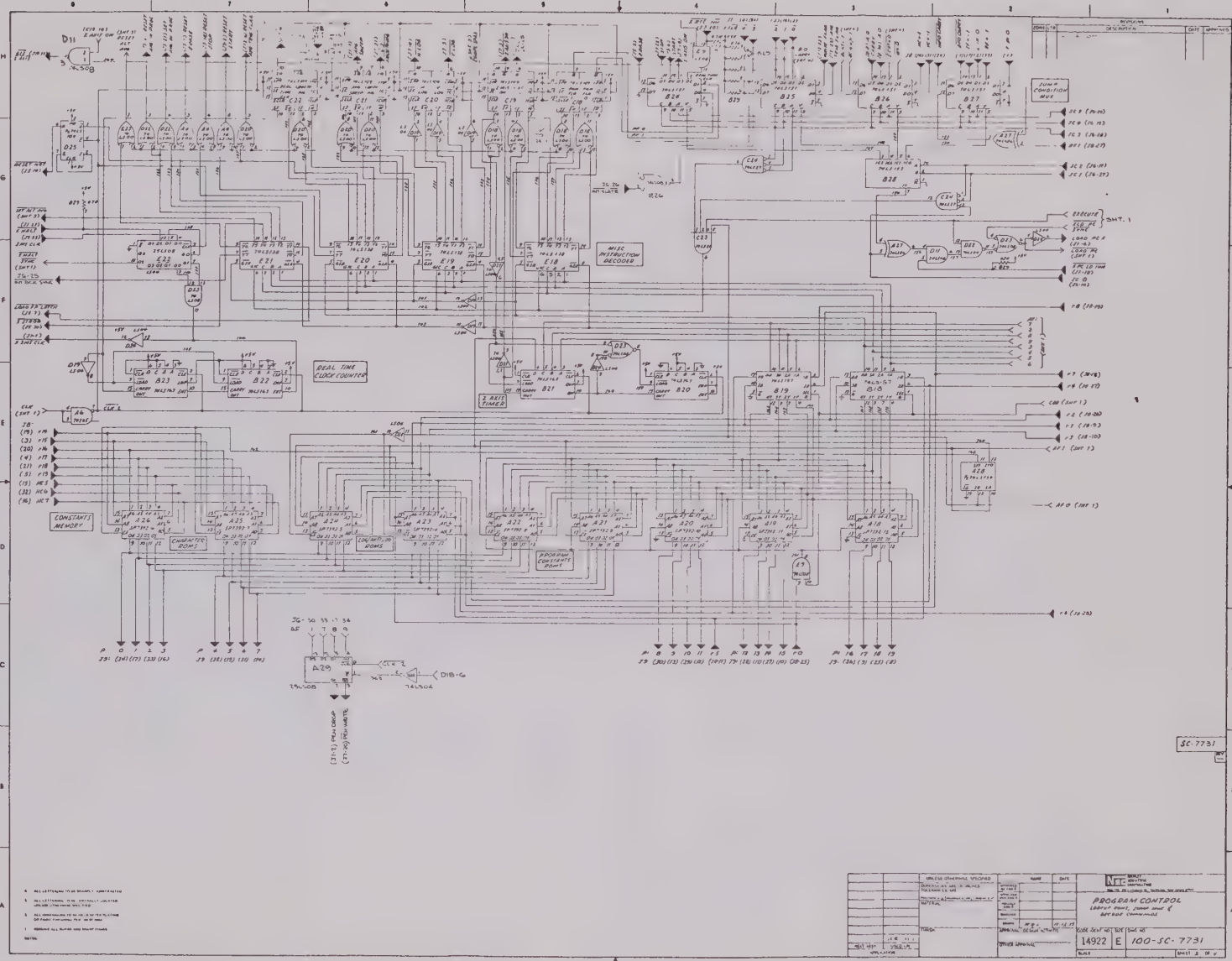
REV D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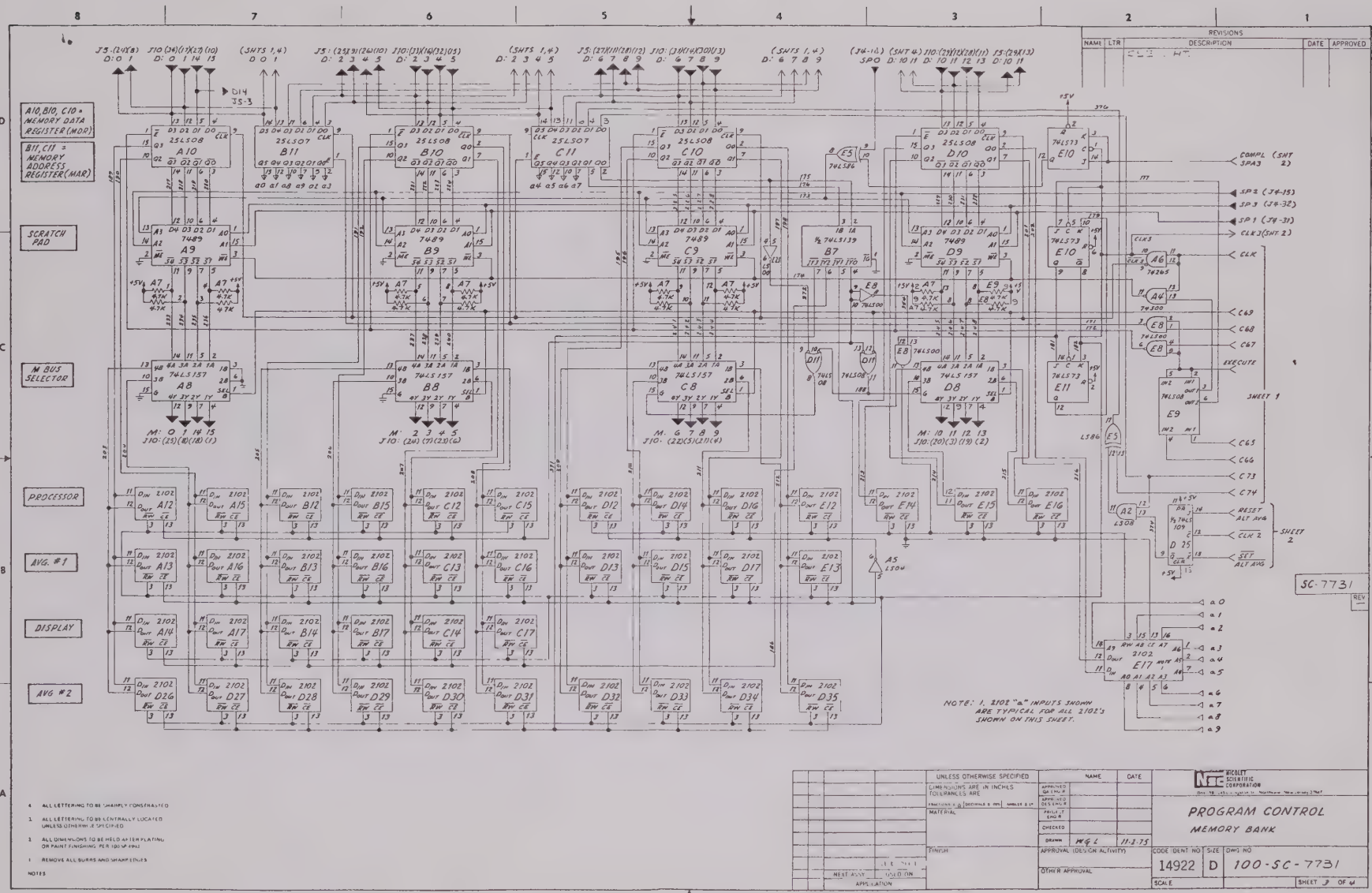
PROGRAM CONSTANTS ROM
CONDITION ROMS
CHARACTER ROMS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B11, C11 = MEMORY ADDRESS REGISTER (MAR)
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M BUS SELECTOR
PROCESSOR
AVG. #1
DISPLAY
AVG #2
REVISIONS
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SC-7731
REV
PROGRAM CONTROL
MEMORY BANK
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UNLESS OTHERWISE SPECIFIED
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APPLICATION
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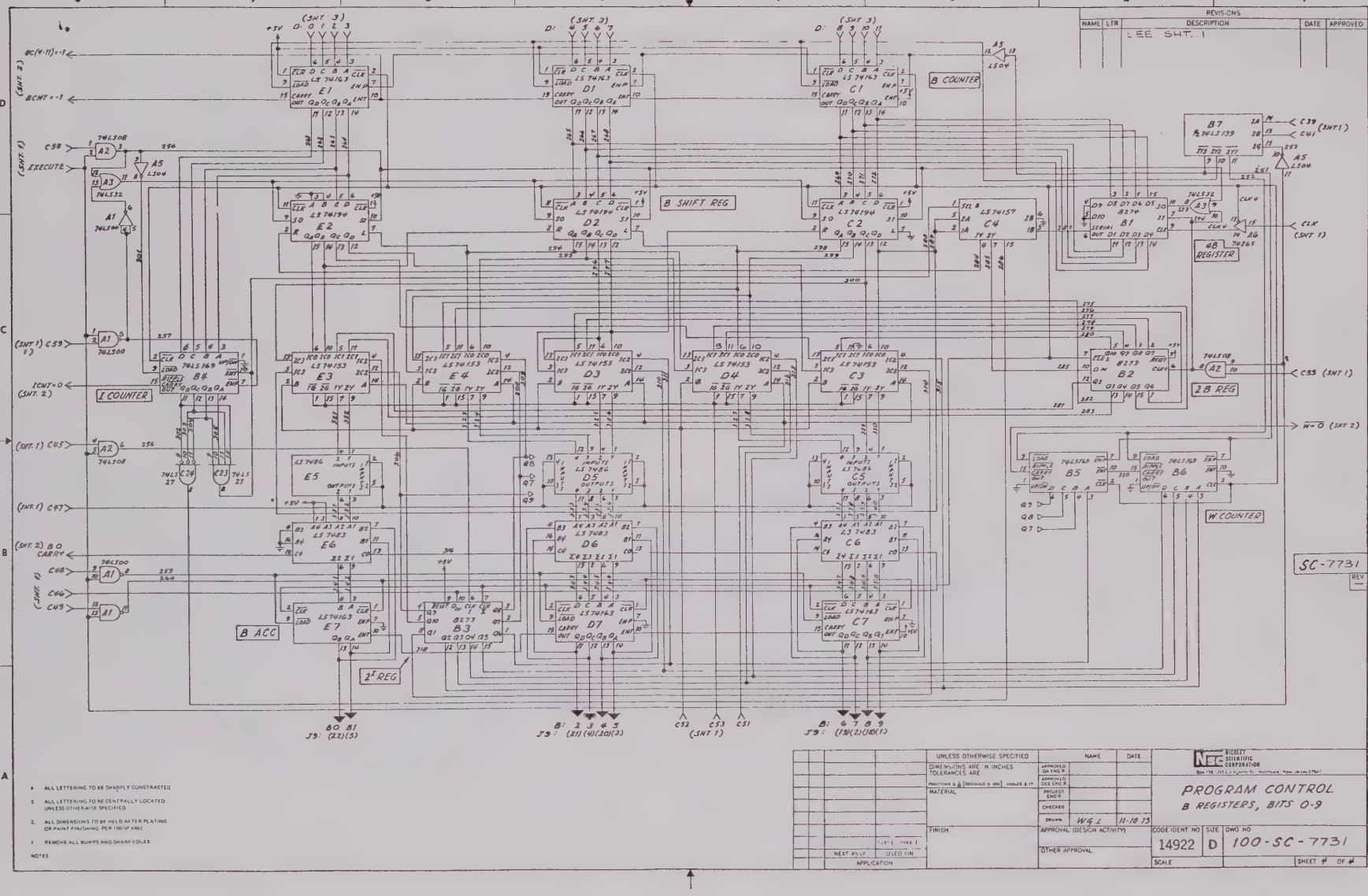
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B SHIFT REG
I COUNTER
B ACC
2I REG
2B REG
W COUNTER
B REGISTER
SC-7731
REV
PROGRAM CONTROL
B REGISTERS, BITS 0-9
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SIZE D
DWG NO 100-SC-7731
SCALE
SHEET # OF #
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
MATERIAL
FINISH
NEXT ASSY
USED ON
APPLICATION
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CHECKED
PROJECT ENG'R
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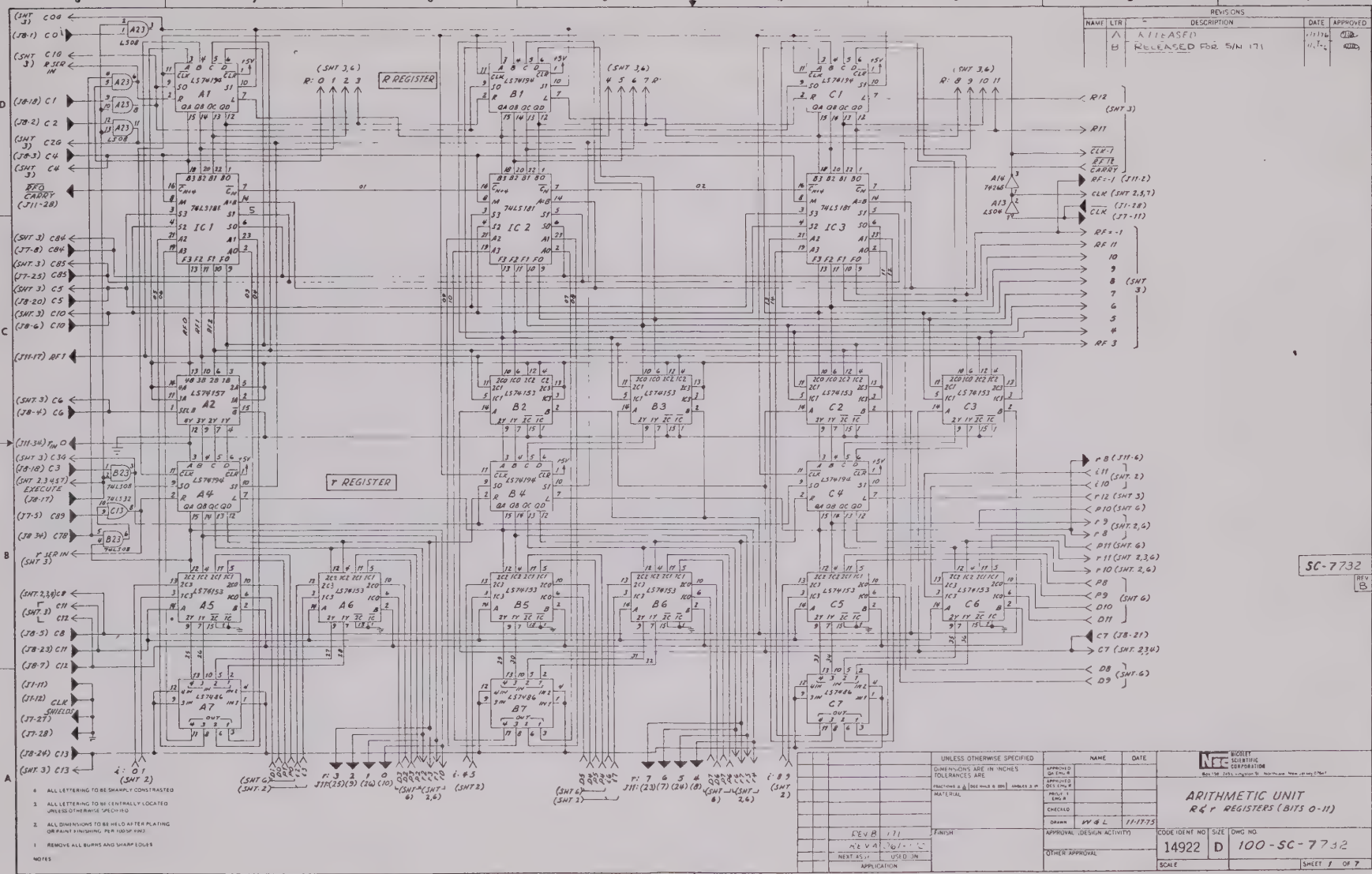
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T REGISTER
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A2
A4
A5
A6
A7
B1
B2
B3
B4
B5
B6
B7
C1
C2
C3
C4
C5
C6
C7
IC1
IC2
IC3
R: 0 1 2 3
R: 4 5 6 7
R: 8 9 10 11
T: 3 2 1 0
T: 7 6 5 4
i: 0 1
i: 2 3
i: 4 5
i: 6 7
i: 8 9
R12 (SHT 3)
R11
RF=-1 (J11-2)
CLK (SHT 2,5,7)
CLK (J1-28)
CLK (J7-11)
RF=-1
RF 11
10
9
8 (SHT 3)
7
6
5
4
RF 3
r8 (J11-6)
t11 (SHT. 2)
t10 (SHT. 2)
r12 (SHT. 3)
P10 (SHT. 6)
r9 (SHT. 2,6)
r8
D11 (SHT. 6)
r11 (SHT 2,3,6)
r10 (SHT. 2,6)
P8
P9 (SHT 6)
D10
D11
C7 (J8-21)
C7 (SHT. 23,4)
D8
D9 (SHT. 6)
(SHT 3) C04
(J8-1) C01
(SHT 3) C16
(J8-18) C1
(J8-2) C2
(SHT 3) C2G
(J8-3) C4
(SHT 3) C4
BRQ CARRY (J11-28)
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(J11-17) RF1
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(J8-4) C6
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(SHT 3) C3G
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(J8-17)
(J7-5) C89
(J8 34) C78
T SEP IN (SHT 3)
(SHT 2,3,6) C8
(SHT 3) C11
C12
(J8-5) C8
(J8-23) C11
(J8-7) C12
(J1-11)
(J1-12) CLK SHIELD
(J7-27)
(J7-28)
(J8-24) C13
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3. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER MIL-STD-105
4. REMOVE ALL BURRS AND SHARP EDGES
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B RELEASED FOR S/N 171
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TOLERANCES ARE
FRACTIONS ± ANGLES ± 1°
MATERIAL
FINISH
NAME DATE
APPROVED
CHECKED
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APPROVAL (DESIGN ACTIVITY)
OTHER APPROVAL
REV B 171
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APPLICATION
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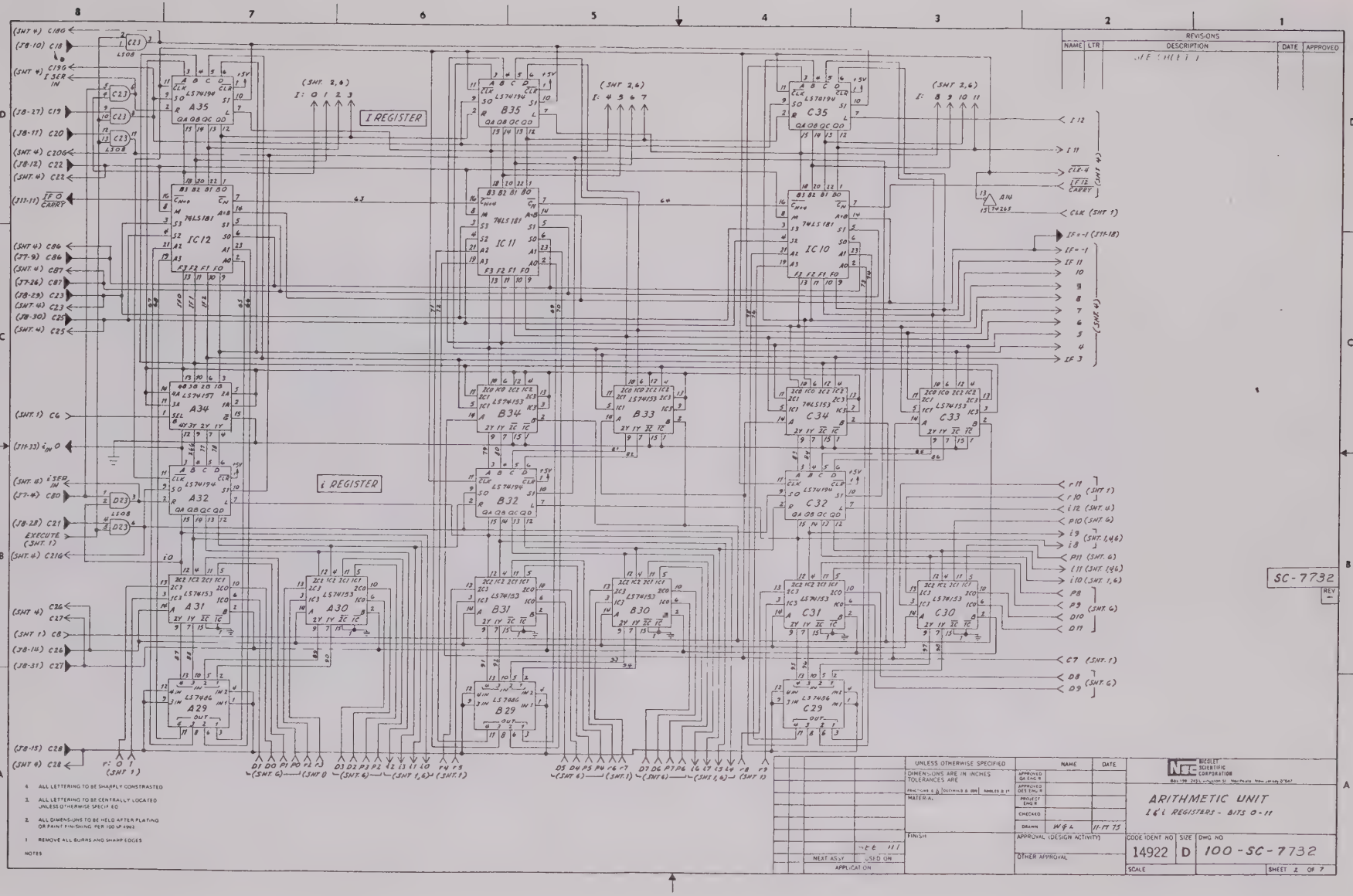
REV B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B35
C35
IC12
IC11
IC10
A34
B34
C34
B33
C33
A32
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A31
B31
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C30
A29
B29
C29
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LS74194
LS74157
LS74153
LS7486
LS08
LS32
LS04
74S265
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DIGITAL SCIENTIFIC CORPORATION
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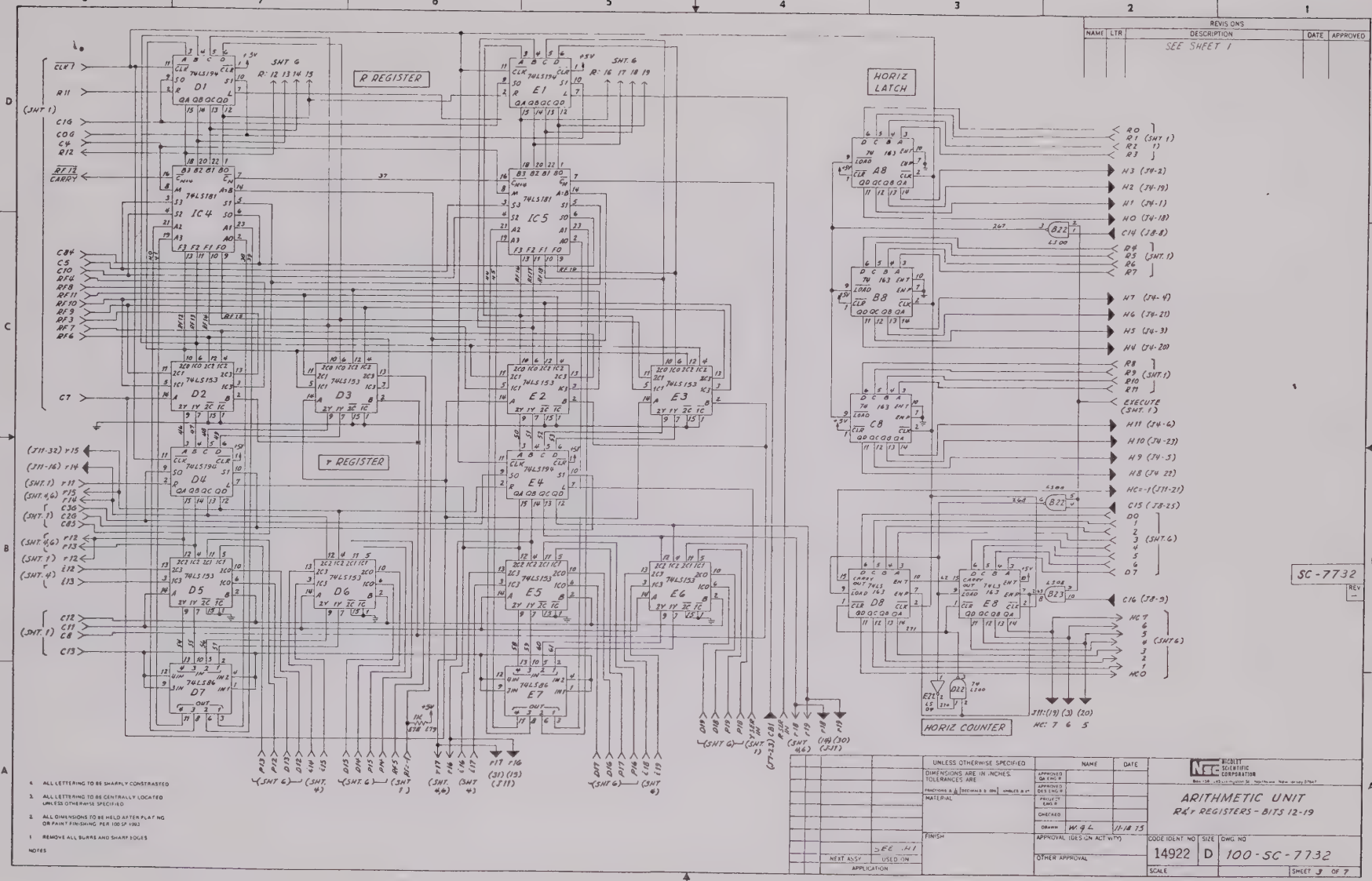
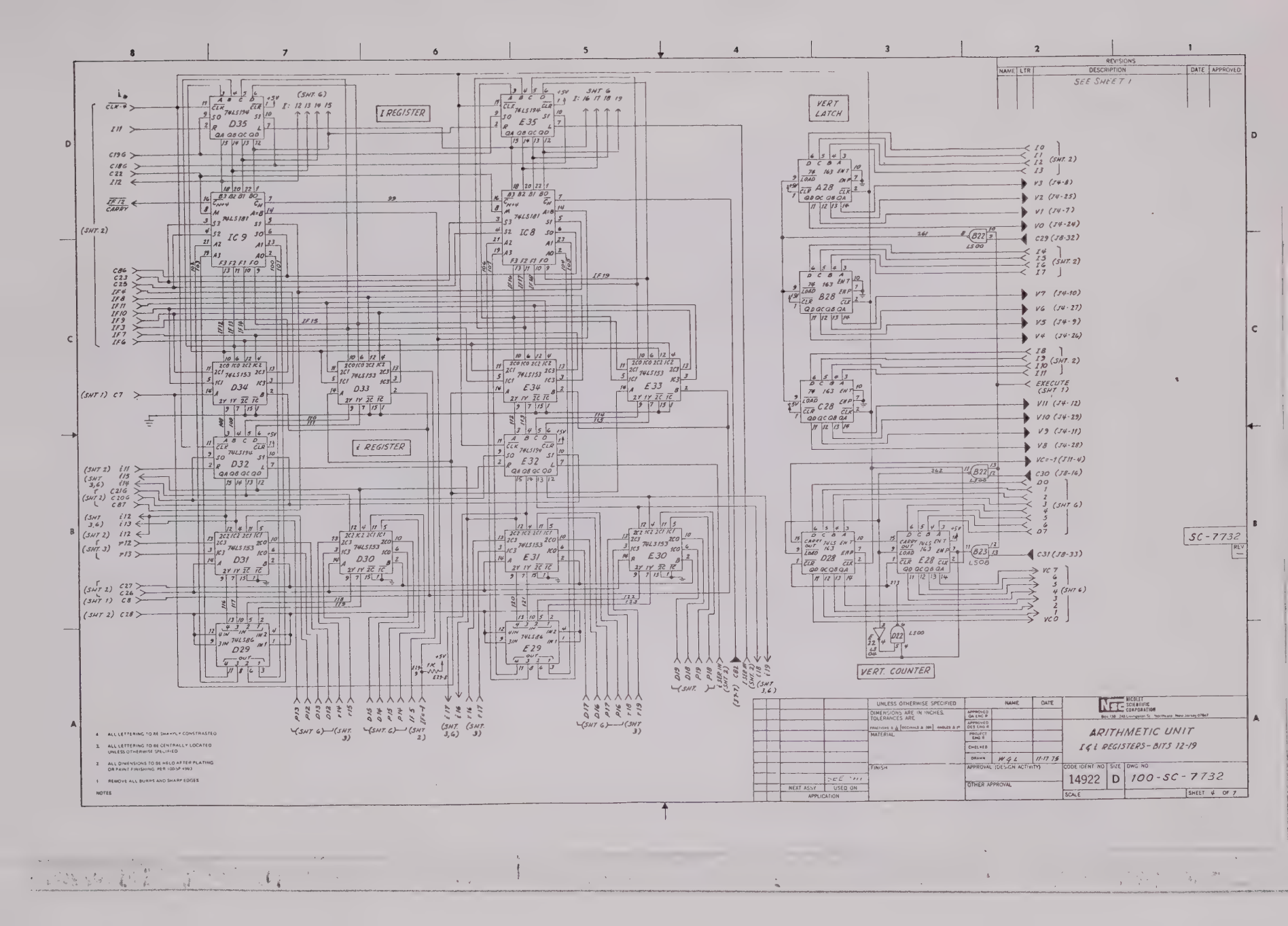
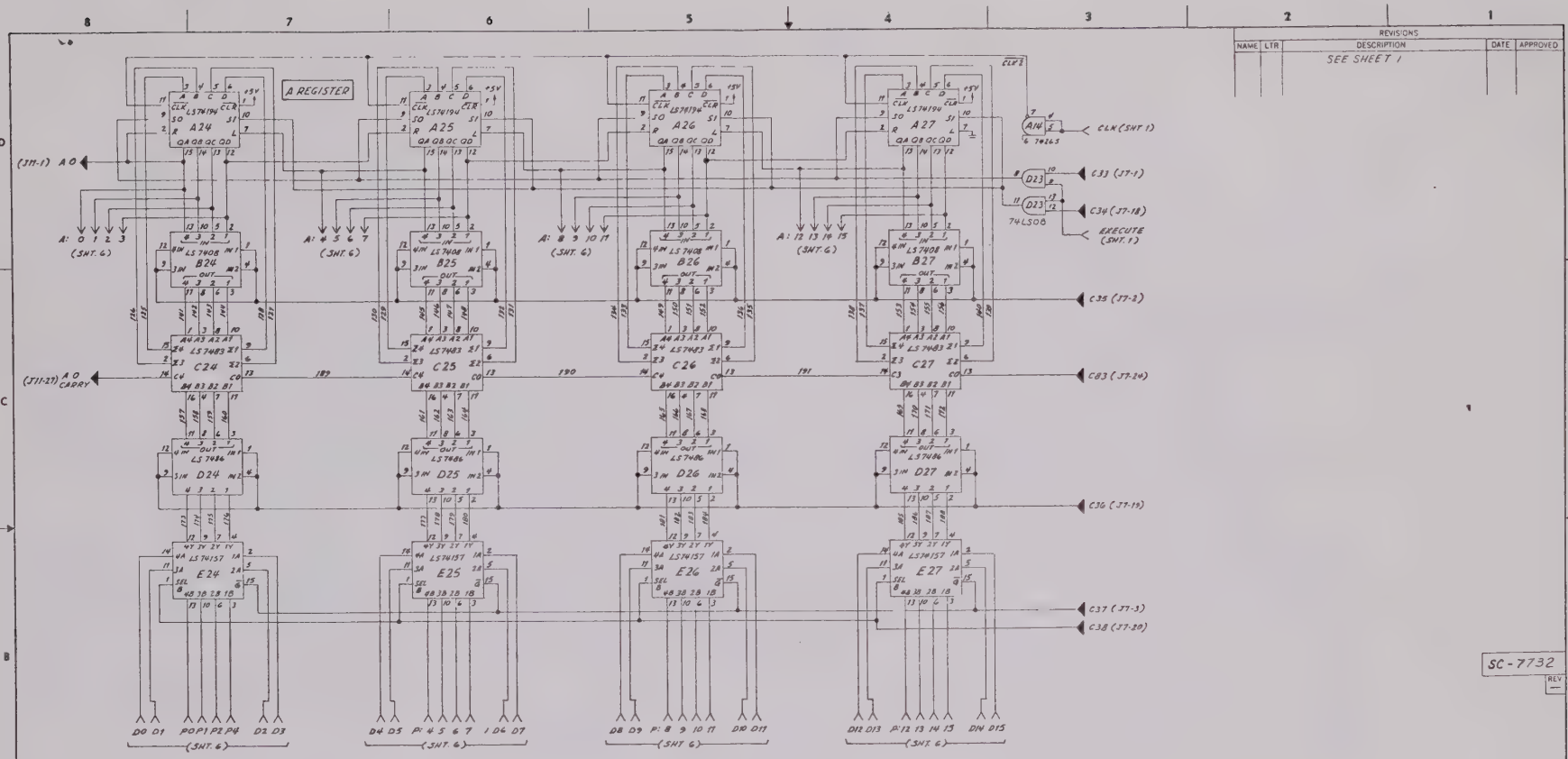
USED ON
APPLICATION
APPROVED
DRAWN W.F.L. 11-17-75
APPROVAL (DESIGN ACTIVITY)
OTHER APPROVAL
SCALE
NOTES
4. ALL LETTERING TO BE SHARPLY CONSTRASTED
3. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIF ED
2. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER 100 SP 4003
1. REMOVE ALL BURRS AND SHARP EDGES


R REGISTER
S REGISTER
HORIZ LATCH
HORIZ COUNTER
D1
D2
D3
D4
D5
D6
D7
E1
E2
E3
E4
E5
E6
E7
IC4
IC5
A8
B8
C8
D8
E8
SEE SHEET 1
SC-7732
ARITHMETIC UNIT
R&S REGISTERS - BITS 12-19
RIGBY SCIENTIFIC CORPORATION
100-SC-7732
14922
SHEET 3 OF 7
W. G. L.
11-14-75
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
MATERIAL
FINISH
NEXT ASSY
USED ON
APPLICATION
OTHER APPROVAL
NOTES
4. ALL LETTERING TO BE SHARPLY CONSTRASTED
3. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
2. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER MIL STD 1963
1. REMOVE ALL BURRS AND SHARP EDGES


I REGISTER
i REGISTER
VERT LATCH
VERT. COUNTER
D35
E35
IC9
IC8
D34
E34
D33
E33
D32
E32
D31
E31
D30
E30
D29
E29
A28
B28
C28
D28
B22
B23
D22
SEE SHEET 1
SC-7732
ARITHMETIC UNIT
I & L REGISTERS - BITS 12-19
14922
D
100-SC-7732
SHEET 4 OF 7
HICKEY SCIENTIFIC CORPORATION
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES.
TOLERANCES ARE:
MATERIAL
FINISH
NEXT ASSY
USED ON
APPLICATION
APPROVAL (DESIGN ACTIVITY)
OTHER APPROVAL
DRAWN
W G L
11-17 78
CHECKED
SCALE
NOTES
4 ALL LETTERING TO BE SHARP + CONSTRASTED
3 ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
2 ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER 100-SP-1963
1 REMOVE ALL BURRS AND SHARP EDGES



REVISIONS				
NAME	LTR	DESCRIPTION	DATE	APPROVED
		SEE SHEET 1		

SC-7732

REV —

NOTES

4 ALL LETTERING TO BE SHARPLY CONSTRASTED

3 ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED

2 ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING, PER MIL-STD-130

1 REMOVE ALL BURRS AND SHARP EDGES

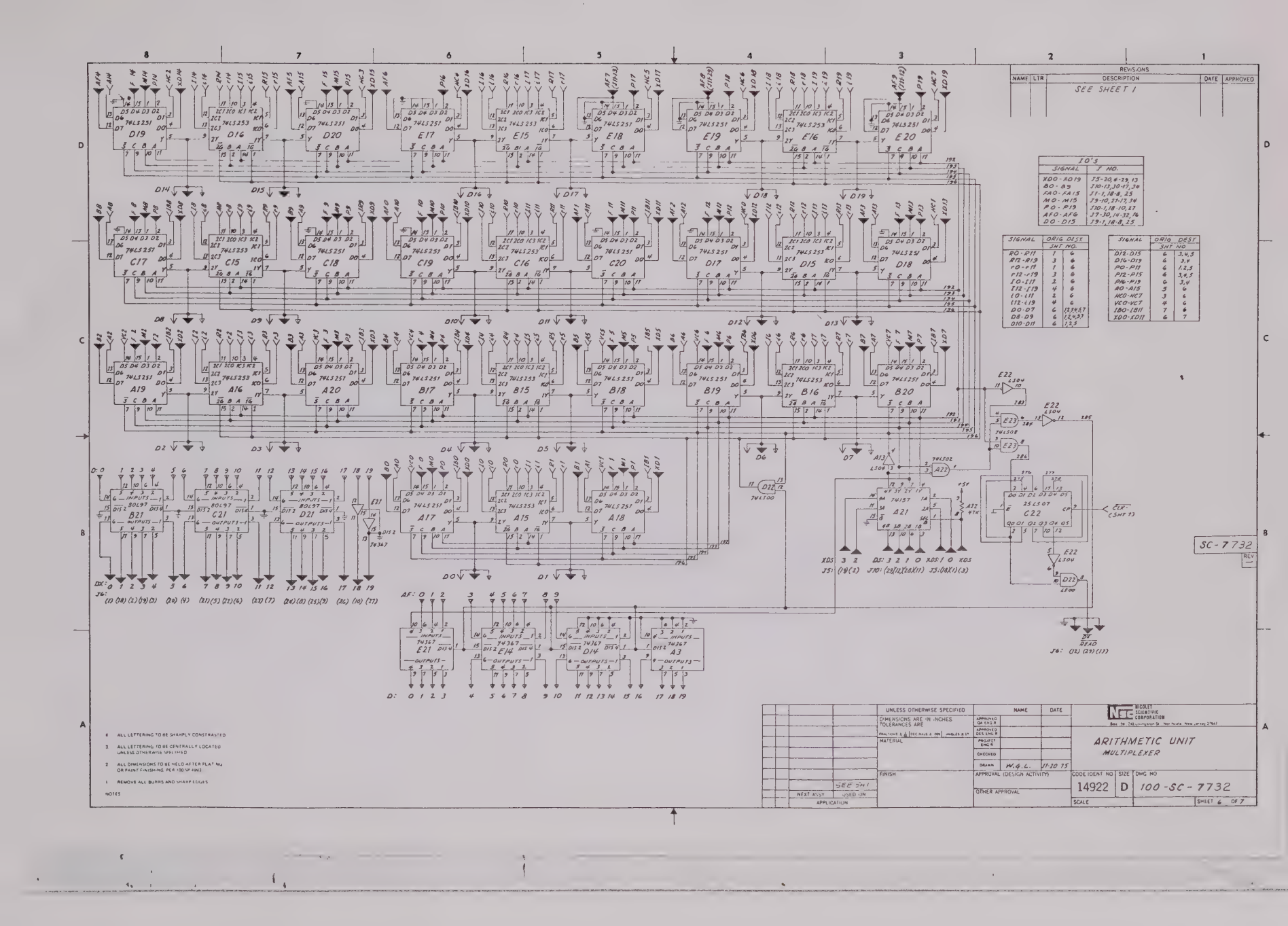
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONS ± | DEC HOLE ± | DEC ± | ANGLES ±
MATERIAL
FINISH
NEXT ASSY | USED ON
APPLICATION

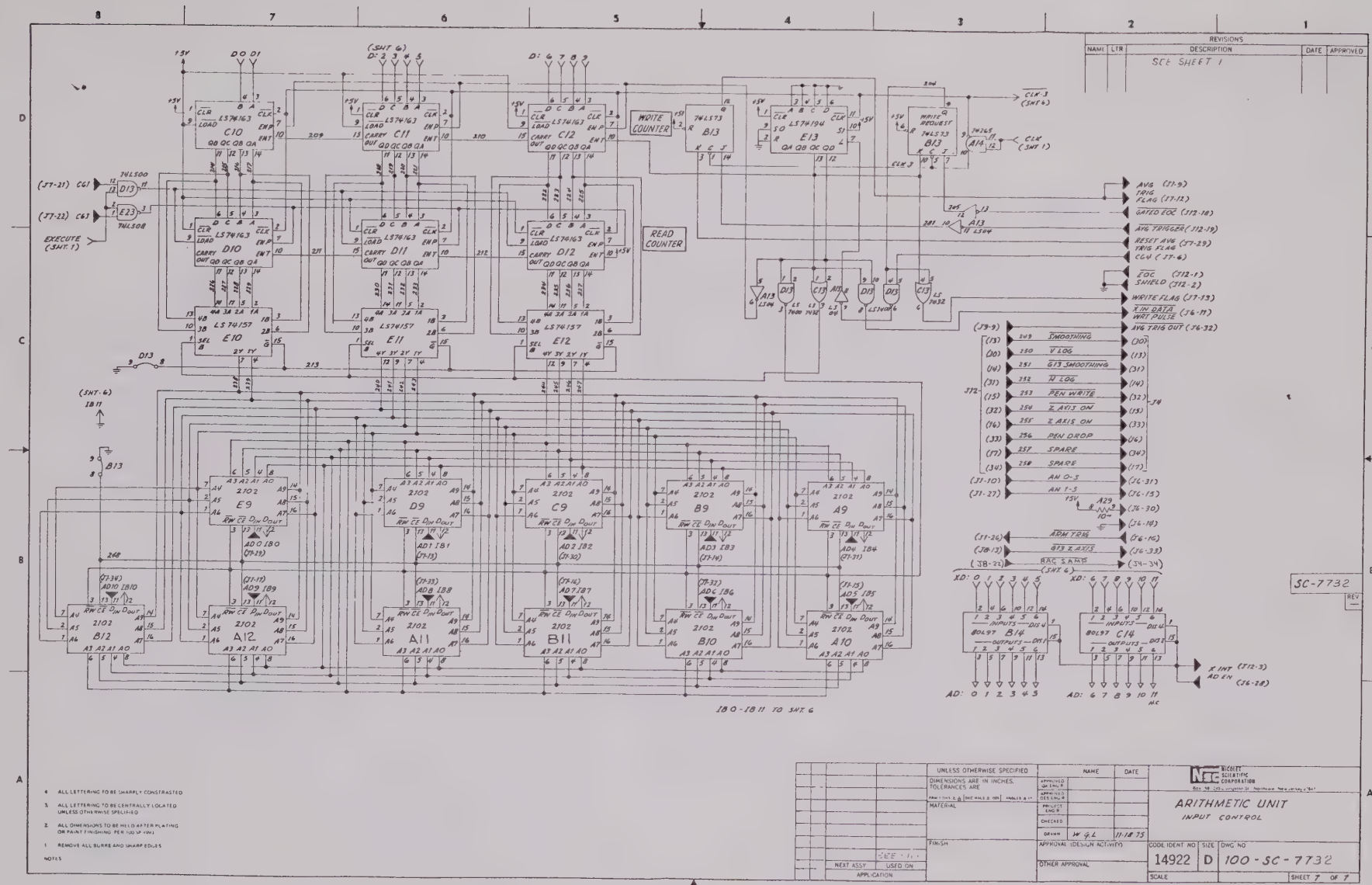
	NAME	DATE
APPROVED QA ENG R		
APPROVED DES ENG R		
PROJ'T ENG R		
CHECKED		
DRAWN	M. S. L.	11-18-75
APPROVAL (DESIGN ACTIVITY)		
OTHER APPROVAL		

NSC NATIONAL SEMICONDUCTOR CORPORATION
Box 158 2401 Kingston St. Northvale, New Jersey 07647

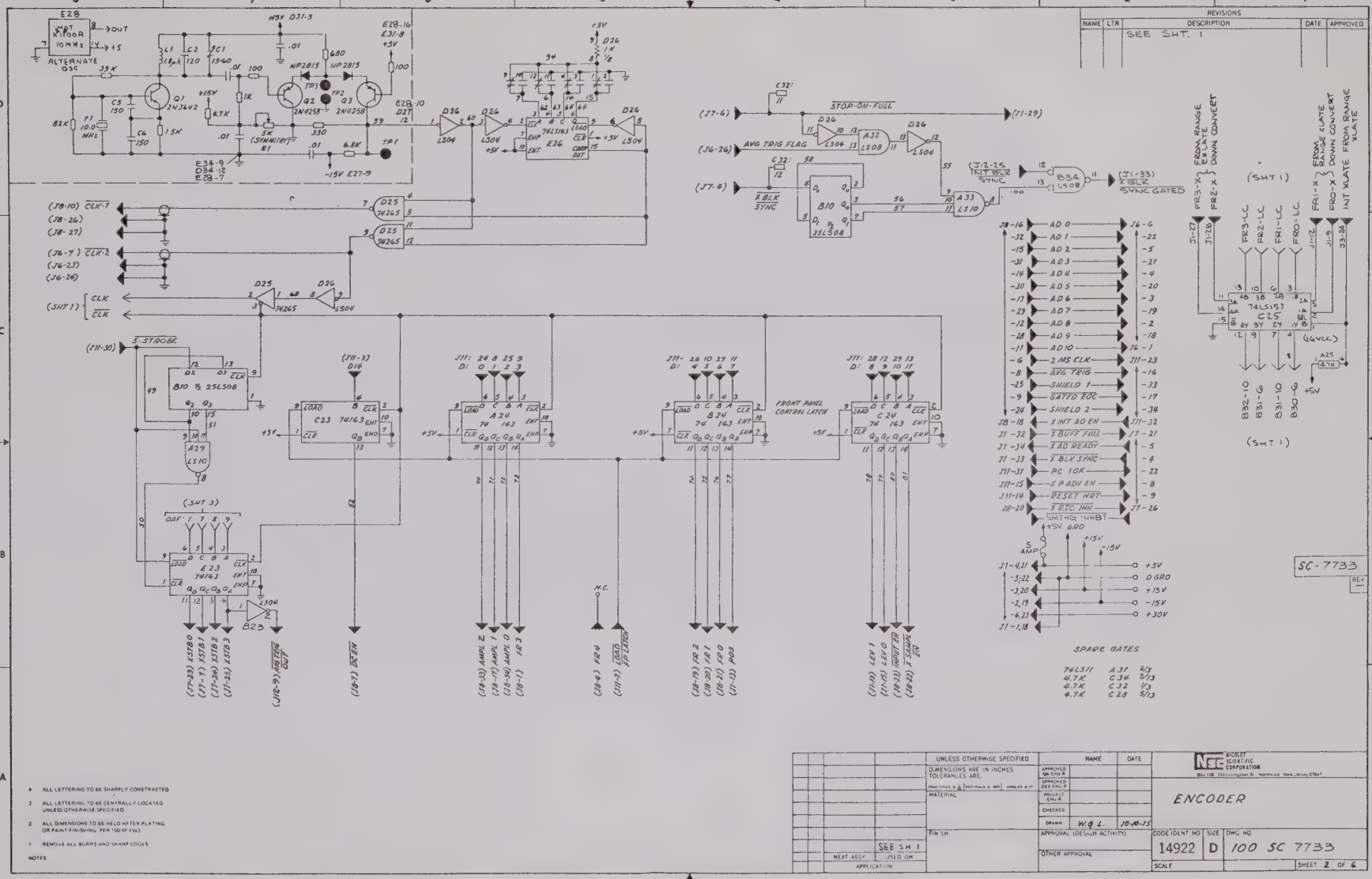
ARITHMETIC UNIT
A REGISTER, BITS 0-15

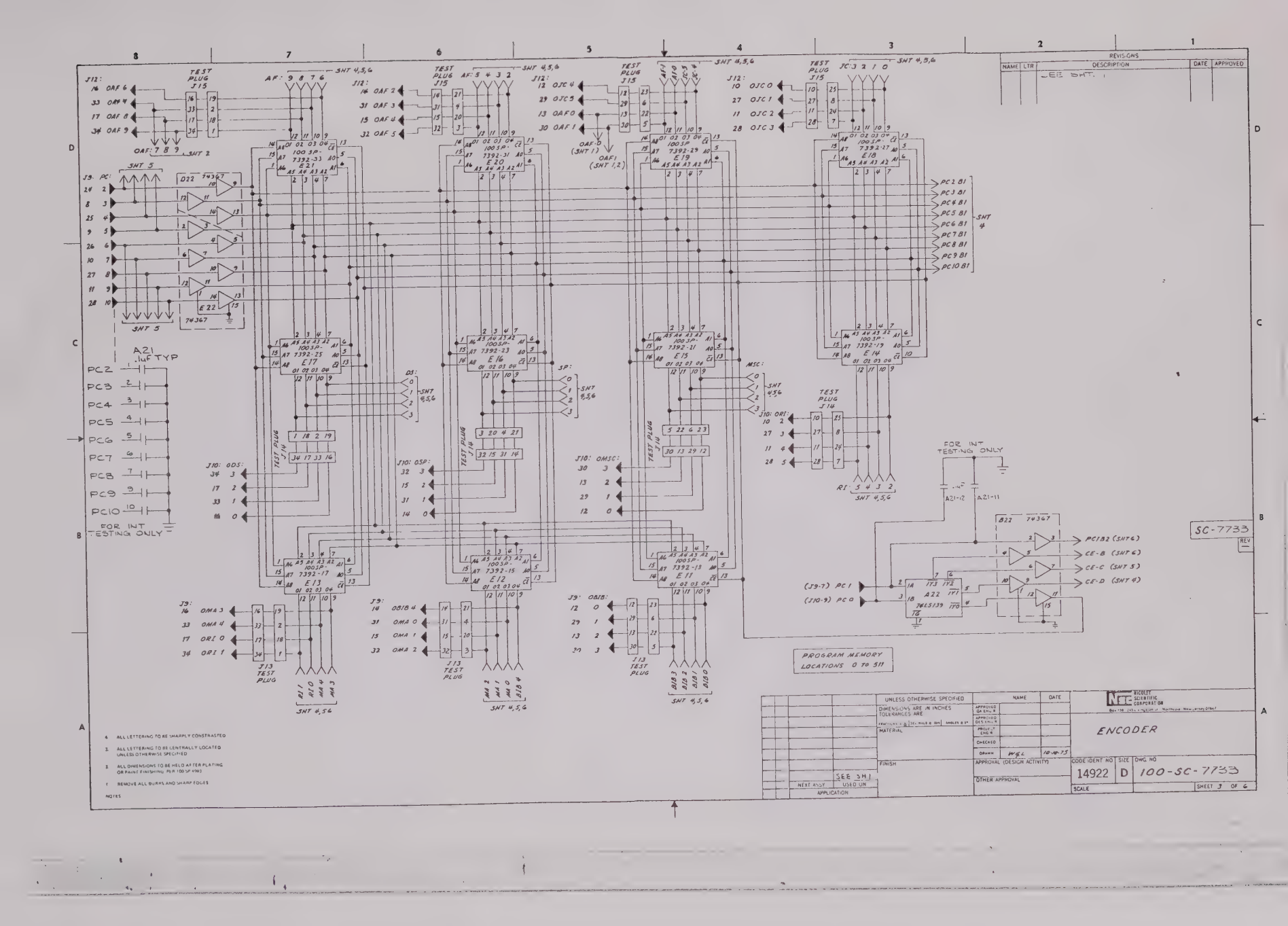
CODE IDENT NO	SIZE	DWG NO
14922	D	100-SC-7732
SCALE		SHEET 5 OF 7

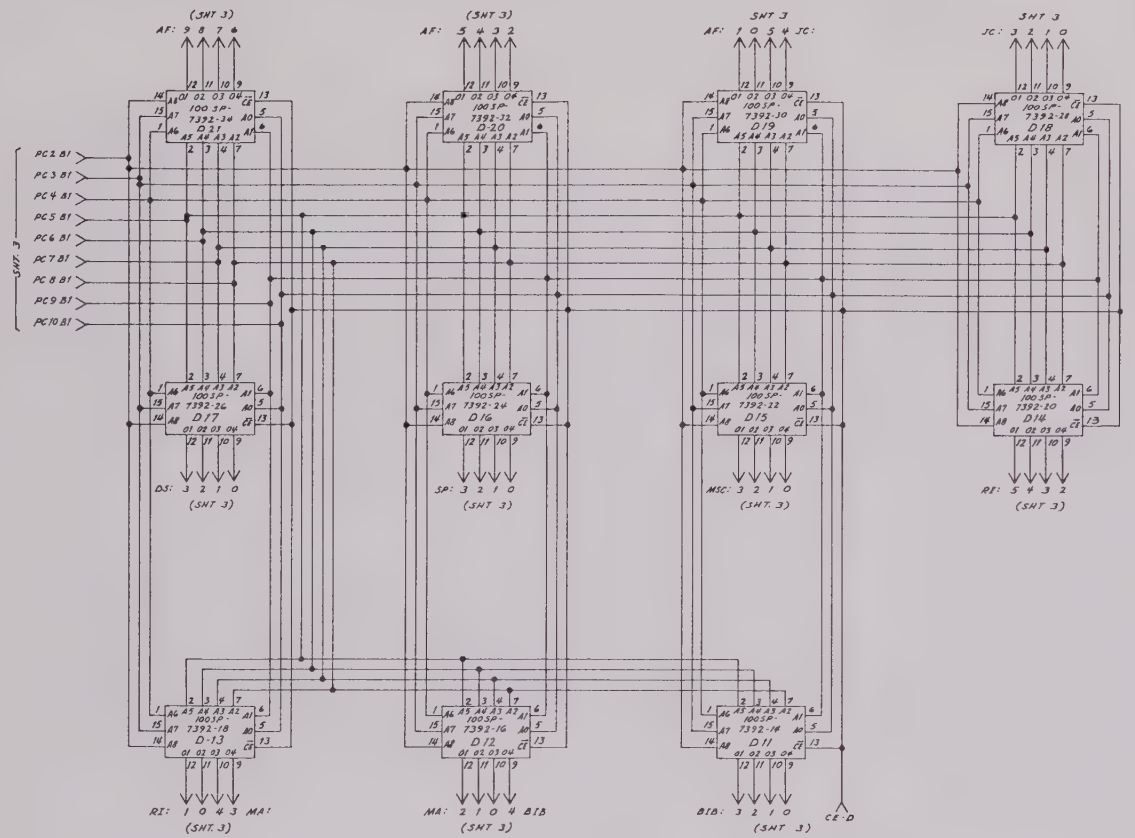

REVISIONS
NAME | LTR | DESCRIPTION | DATE | APPROVED
SEE SHEET 1
I/O'S
SIGNAL | J NO.
XDO-XD19 | J5-20,4-29,13
BO-B9 | J10-13,30-17,30
FAO-FA15 | J1-1,18-8,25
MO-M15 | J3-10,27-17,24
PO-P19 | J10-1,18-10,17
AFO-AF6 | J7-30,14-32,16
DO-D15 | J9-1,18-8,25
SIGNAL | ORIG DEST SHT NO
RO-R11 | 1 6
R12-R19 | 3 6
rO-r11 | 1 6
r12-r19 | 3 6
IO-I11 | 2 6
I12-I19 | 4 6
lO-l11 | 2 6
l12-l19 | 4 6
DO-D7 | 6 (13,14,15,17)
D8-D9 | 6 (12,13)
D10-D11 | 6 (2,3)
SIGNAL | ORIG DEST SHT NO
D12-D15 | 6 3,4,5
D16-D19 | 6 3,4
PO-P11 | 6 1,2,3
P12-P15 | 6 3,4,5
P16-P19 | 6 3,4
AO-A15 | 5 6
MCO-MC7 | 3 6
VCO-VC7 | 4 6
IBO-IB11 | 7 6
XDO-XD11 | 6 7
SC-7732
REV
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
MATERIAL
FINISH
NEXT ASSY
USED ON
APPLICATION
NAME | DATE
APPROVED QA ENG'R
APPROVED DES ENG'R
PROJECT ENG'R
CHECKED
DRAWN W.G.L. 11-20 75
APPROVAL (DESIGN ACTIVITY)
OTHER APPROVAL
NICOLET SCIENTIFIC CORPORATION
ARITHMETIC UNIT
MULTIPLEXER
CODE IDENT NO 14922
SIZE D
DWG NO 100-SC-7732
SCALE
SHEET 6 OF 7
1 ALL LETTERING TO BE SHARPLY CONSTRASTED
2 ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
3 ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER 100 UP 4INCH
4 REMOVE ALL BURRS AND SHARP EDGES
NOTES


REVISIONS
NAME | LTR | DESCRIPTION | DATE | APPROVED
SEE SHEET 1
WRITE COUNTER
READ COUNTER
EXECUTE (SHT. 1)
(J7-21) CG1
(J7-22) CG3
AVG (J7-9)
TRIG FLAG (J7-12)
GATED EOC (J12-18)
AVG TRIGGER (J12-19)
RESET AVG TRIG FLAG (J7-29)
CLK (J7-6)
EOC (J12-1)
SHIELD (J12-2)
WRITE FLAG (J7-13)
X IN DATA WRT PULSE (J6-11)
AVG TRIG OUT (J6-32)
SMOOTHING
V LOG
G13 SMOOTHING
N LOG
PEN WRITE
Z AXIS ON
PEN DROP
SPARE
SPARE
AN 0-5
AN 1-5
ARM TRIG
G13 Z AXIS
MAG SAMP (SHT 6)
X INT (J12-3)
AD EN (J6-28)
I80-I811 TO SHT 6
SC-7732
REV
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
MATERIAL
FINISH
NEXT ASSY
USED ON
APPLICATION
NAME
DATE
DRAWN
W G L
11-18 75
OTHER APPROVAL
NICOLET SCIENTIFIC CORPORATION
ARITHMETIC UNIT
INPUT CONTROL
CODE IDENT NO
14922
SIZE
D
DWG NO
100 - SC - 7732
SCALE
SHEET 7 OF 7
1. REMOVE ALL BURRS AND SHARP EDGES
2. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER 100 SP 1041
3. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
4. ALL LETTERING TO BE SHARPLY CONSTRASTED
NOTES

REVISIONS
NAME | LTR | DESCRIPTION | DATE | APPROVED
A REDRAWN
B REVISED
C ECO 2383, REVISED SH 1 & 2
D ECO 2349, 2451
ENCODER
SC-7733
REV D
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
MATERIAL
FINISH
NEXT ASSY
USED ON
APPLICATION
APPROVED
CHECKED
DRAWN
APPROVAL (DESIGN ACTIVITY)
OTHER APPROVAL
CODE IDENT NO
14922
SIZE
D
DWG NO
100-SC-7733
SCALE
SHEET 1 OF 6
NOTES
1. ALL LETTERING TO BE SHARPLY CONSTRASTED
2. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED.
3. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER 100-SP-1003
4. REMOVE ALL BURRS AND SHARP EDGES


REVISIONS
NAME | LTR | DESCRIPTION | DATE | APPROVED
SEE SHT. 1
ENCODER
SC-7733
REV —
FRONT PANEL CONTROL LATCH
SPARE GATES
NOTES
1 REMOVE ALL BURRS AND SHARP EDGES
2 ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER MIL-STD-SP-6Nb3
3 ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
4 ALL LETTERING TO BE SHARPLY CONSTRASTED
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
MATERIAL
FINISH
NEXT ASSY
APPLICATION
NAME
DATE
APPROVED
CHECKED
DRAWN W.G.L. 10-10-75
APPROVAL (DESIGN ACTIVITY)
OTHER APPROVAL
NICKLET SCIENTIFIC CORPORATION
CODE IDENT NO 14922
SIZE D
DWG NO 100 SC 7733
SCALE
SHEET 2 OF 6


REVISIONS
NAME LTR DESCRIPTION DATE APPROVED
SEE SHT. 1
SC-7733
REV
PROGRAM MEMORY LOCATIONS 0 TO 511
FOR INT TESTING ONLY
A21 .1uF TYP
ENCODER
CODE IDENT NO 14922
SIZE D
DWG NO 100-SC-7733
SHEET 3 OF 6
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
MATERIAL
FINISH
NEXT ASSY SEE SH1
USED ON
APPLICATION
DRAWN WGL 10-10-75
APPROVAL (DESIGN ACTIVITY)
OTHER APPROVAL
SCALE
1. ALL LETTERING TO BE SHARPLY CONSTRASTED
2. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
3. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER 100 SP 4703
4. REMOVE ALL BURRS AND SHARP EDGES
NOTES



REVISIONS				
NAME	LTR	DESCRIPTION	DATE	APPROVED
		SEE SHT. 1		

SC-7733

REV —

PROGRAM MEMORY
LOCATIONS 512 TO 1023

NOTES

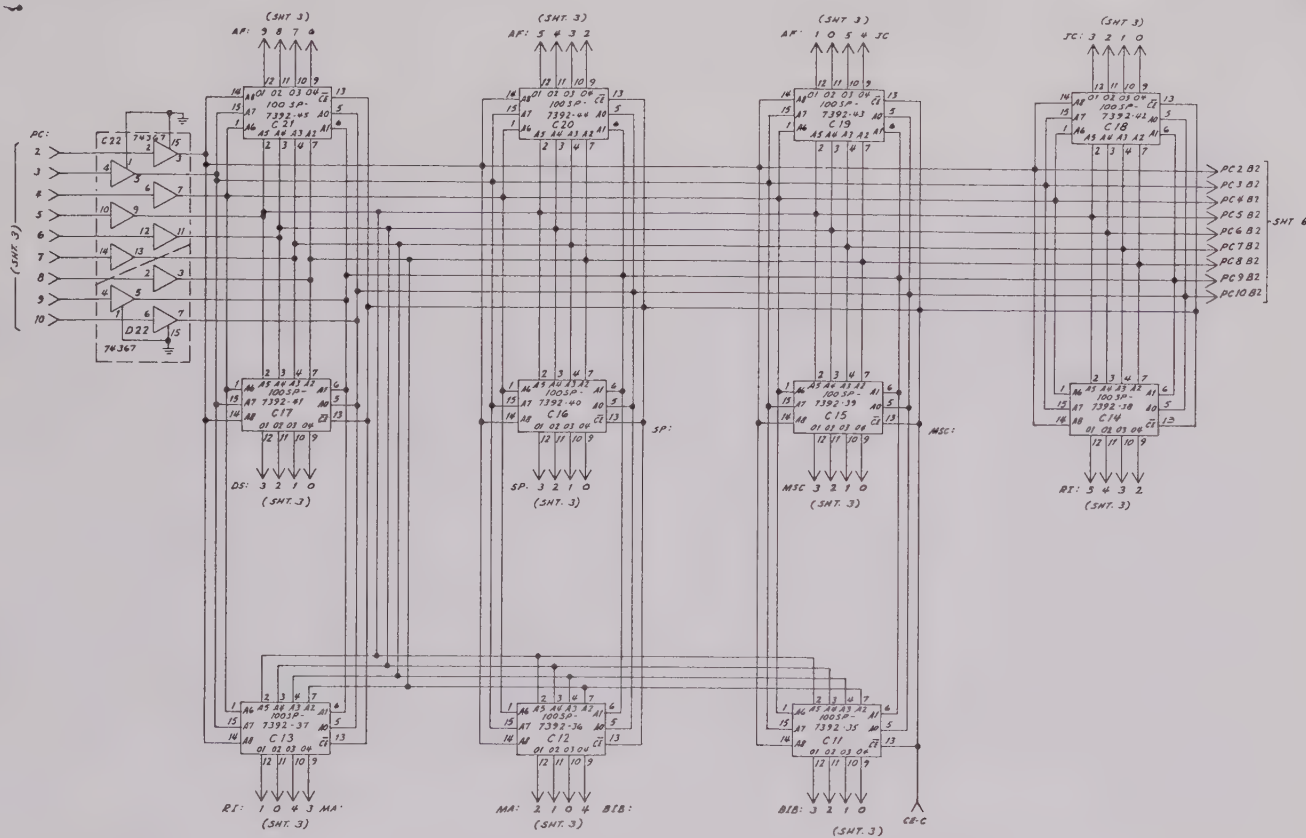
4. ALL LETTERING TO BE SHARPLY CONTRASTED
3. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
2. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER MIL-STD-1803
1. REMOVE ALL BURRS AND SHARP EDGES

	NAME	DATE
UNLESS OTHERWISE SPECIFIED		
DIMENSIONS ARE IN INCHES	APPROVED QA ENG'R	
TOLERANCES ARE	APPROVED DES ENG'R	
FRACTIONS ±	DECIMALS & .XXX	ANGLES ± 1°	MFG'G ENG'R	
MATERIAL	CHECKED	
	DRAWN	W.G.L.	10-10-73
FINISH	APPROVAL (DESIGN ACTIVITY)	
SEE SH 1	OTHER APPROVAL	
NEXT ASSY USED ON		
APPLICATION		

NICOLET SCIENTIFIC CORPORATION
Box 154 • 63 Livingston St. • Northvale, New Jersey 07647

ENCODER

CODE IDENT NO	SIZE	DWG NO
14922	D	100-SC-7733
SCALE		SHEET 4 OF 6



PROGRAM MEMORY
LOCATIONS 1024 TO 1535

REVISIONS				
NAME	LTR	DESCRIPTION	DATE	APPROVED
		[illegible]		

SC-7733
REV —

4 ALL LETTERING TO BE SHARPLY CONSTRASTED

3 ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED

2 ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER 100 SP 4M3

1 REMOVE ALL BURRS AND SHARP EDGES

NOTES

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONS ± [illegible] DECIMALS .X ± .03 | .XX ± .01 | ANGLES ± 1°
MATERIAL
FINISH
NEXT ASSY | USED ON
APPLICATION
See SHT 1

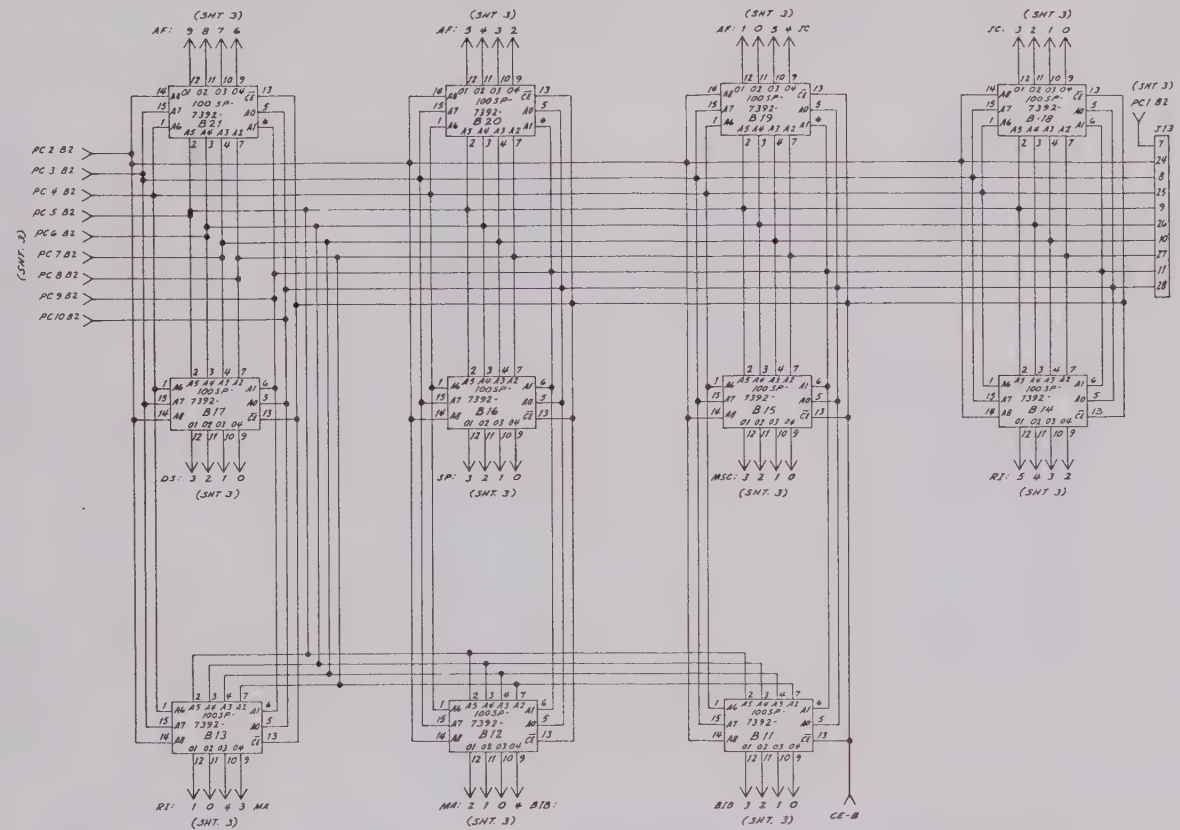
	NAME	DATE
APPROVED QA ENG'R		
APPROVED DES. ENG'R		
PROJECT ENG'R		
CHECKED		
DRAWN	WGL	10-10-75
APPROVAL DESIGN ACTIVITY		
OTHER APPROVAL		

NICOLET SCIENTIFIC CORPORATION
[illegible]

ENCODER

CODE IDENT NO	SIZE	DWG NO
14922	D	100-SC-7733

SCALE
SHEET 5 OF 6



REVISIONS				
NAME	LTR	DESCRIPTION	DATE	APPROVED

PROGRAM MEMORY LOCATIONS 1536 TO 2047

SC-7733 REV

NOTES:
4. ALL LETTERING TO BE SHARPLY CONSTRASTED
3. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
2. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINTING PER MIL-P-XXXX
1. REMOVE ALL BURRS AND SHARP EDGES

	NAME	DATE
UNLESS OTHERWISE SPECIFIED		
DIMENSIONS ARE IN INCHES TOLERANCES ARE		
FRACTIONS ±	DECIMALS ±	ANGLES ±
MATERIAL		
FINISH		
APPROVED QA ENG R		
APPROVED DES ENG R		
PROJECT ENG R		
CHECKED		
DRAWN	WKL	10-10-73
APPROVAL (DESIGN ACTIVITY)		
OTHER APPROVAL		
NEXT ASSY	SEE SH 1	
USED ON		
APPLICATION		

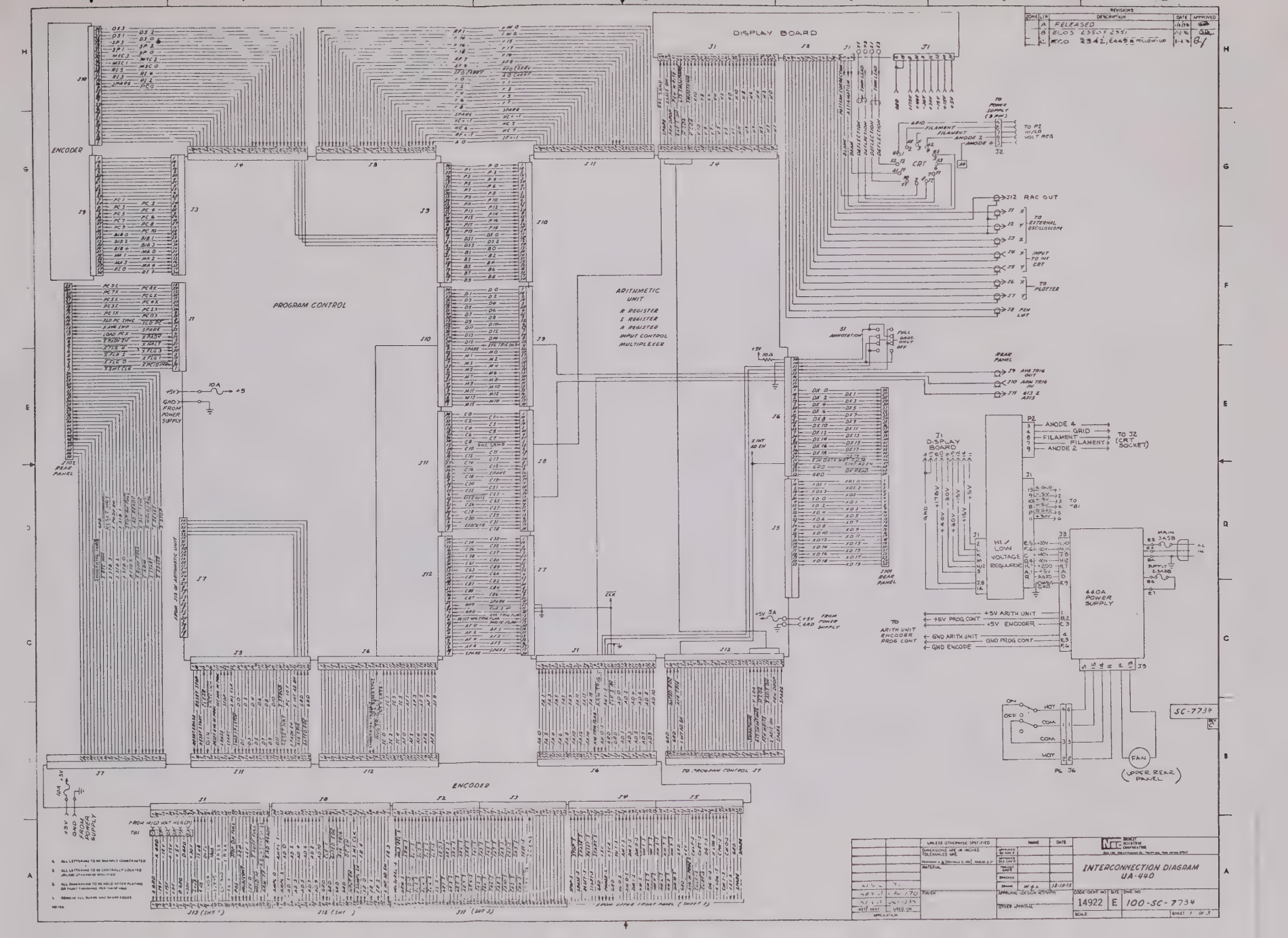
HEWLETT SCIENTIFIC CORPORATION

ENCODER

CODE IDENT NO	SIZE	DWG NO
14922	D	100-SC-7733

SCALE

SHEET 6 OF 6



ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED	1/1/76	
	B	ECO 2351, 2351	4-6-76	
	C	ECO 2342, 2448 & FOLLOW-UP	8-4-76	BJ

1. ALL LETTERING TO BE SHARPLY CONSTRUCTED
2. ALL LETTERING TO BE CENTERALLY LOCATED UNLESS OTHERWISE SPECIFIED
3. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT THICKNESS PER TOP OF HOLE
4. REMOVE ALL BURRS AND SHARP EDGES

NO 186

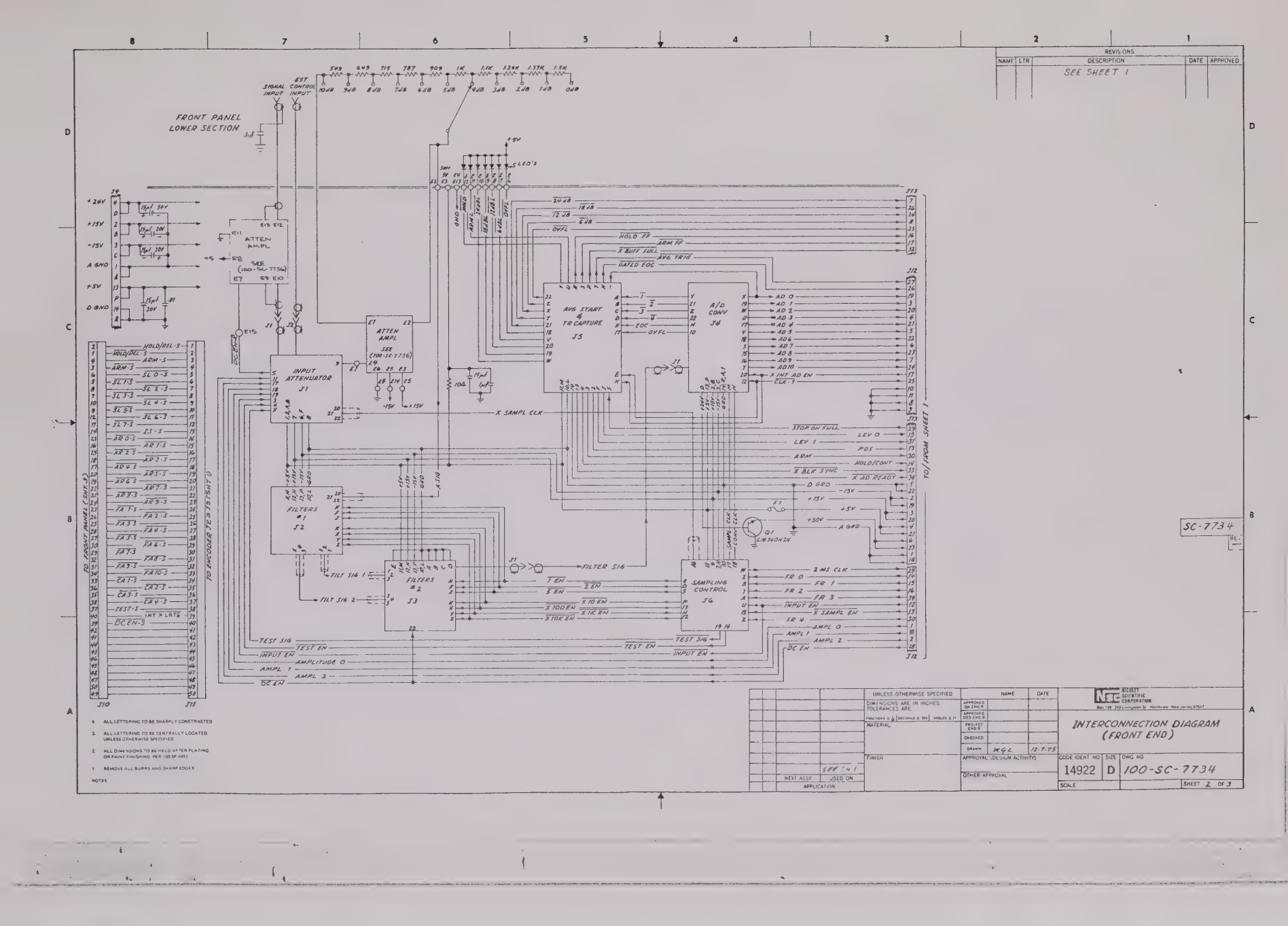
UNLESS OTHERWISE SPECIFIED	NAME	DATE
DIMENSIONS ARE IN INCHES TOLERANCES ARE	APPROVED (2 DEC ±)	
FRACTIONS ± DECIMALS ± ANGLES ±	APPROVED (3 DEC ±)	
MATERIAL	PROJECT ENGR	
	ENGINEER	
	DRAWN	M.G.A. 12-13-73
FINISH	APPLICATION	
NEXT ASSY	USED ON	
APPLICATION	OTHER APPROVAL	

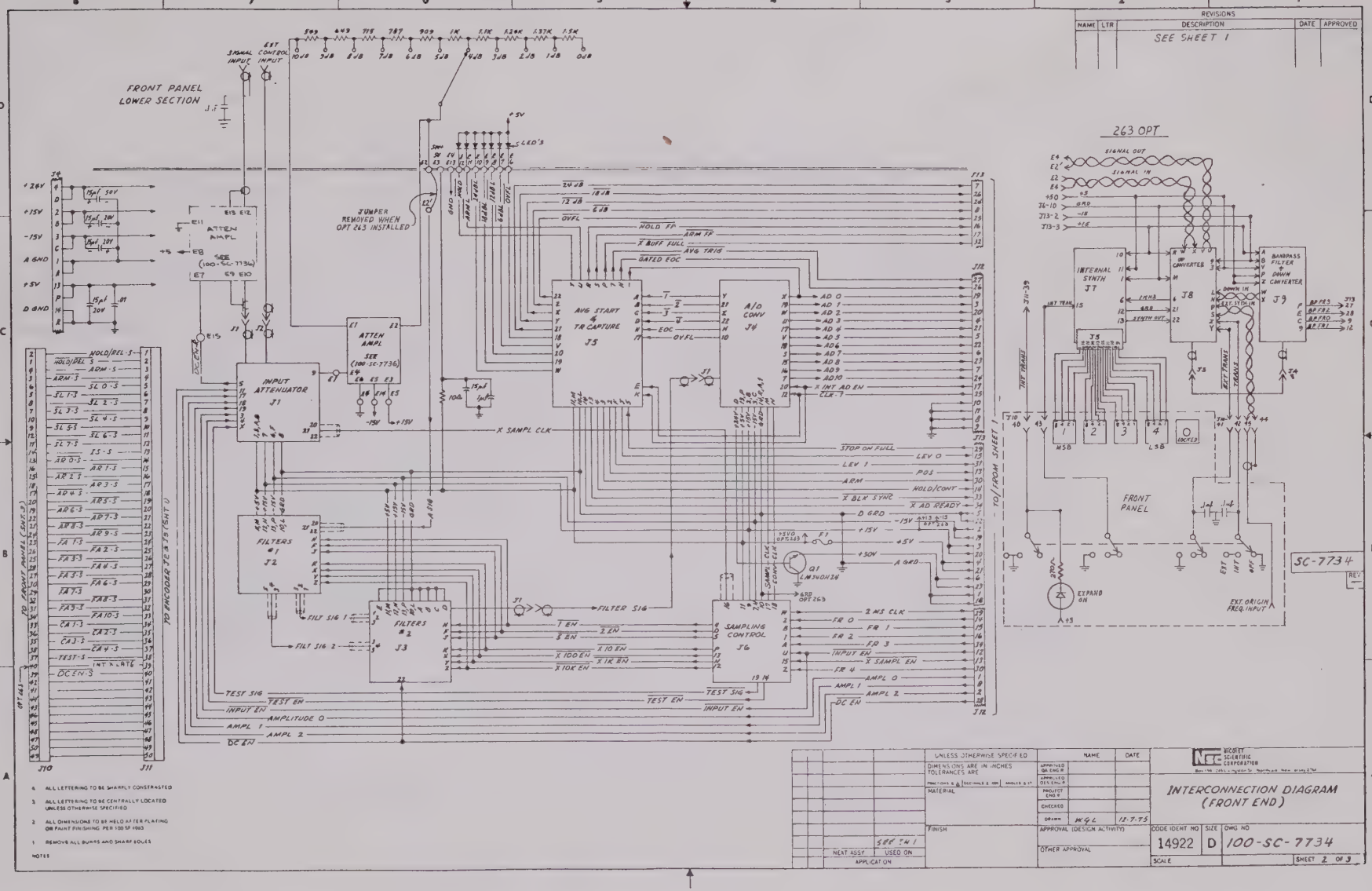
NCR ROCKET RESEARCH CORPORATION

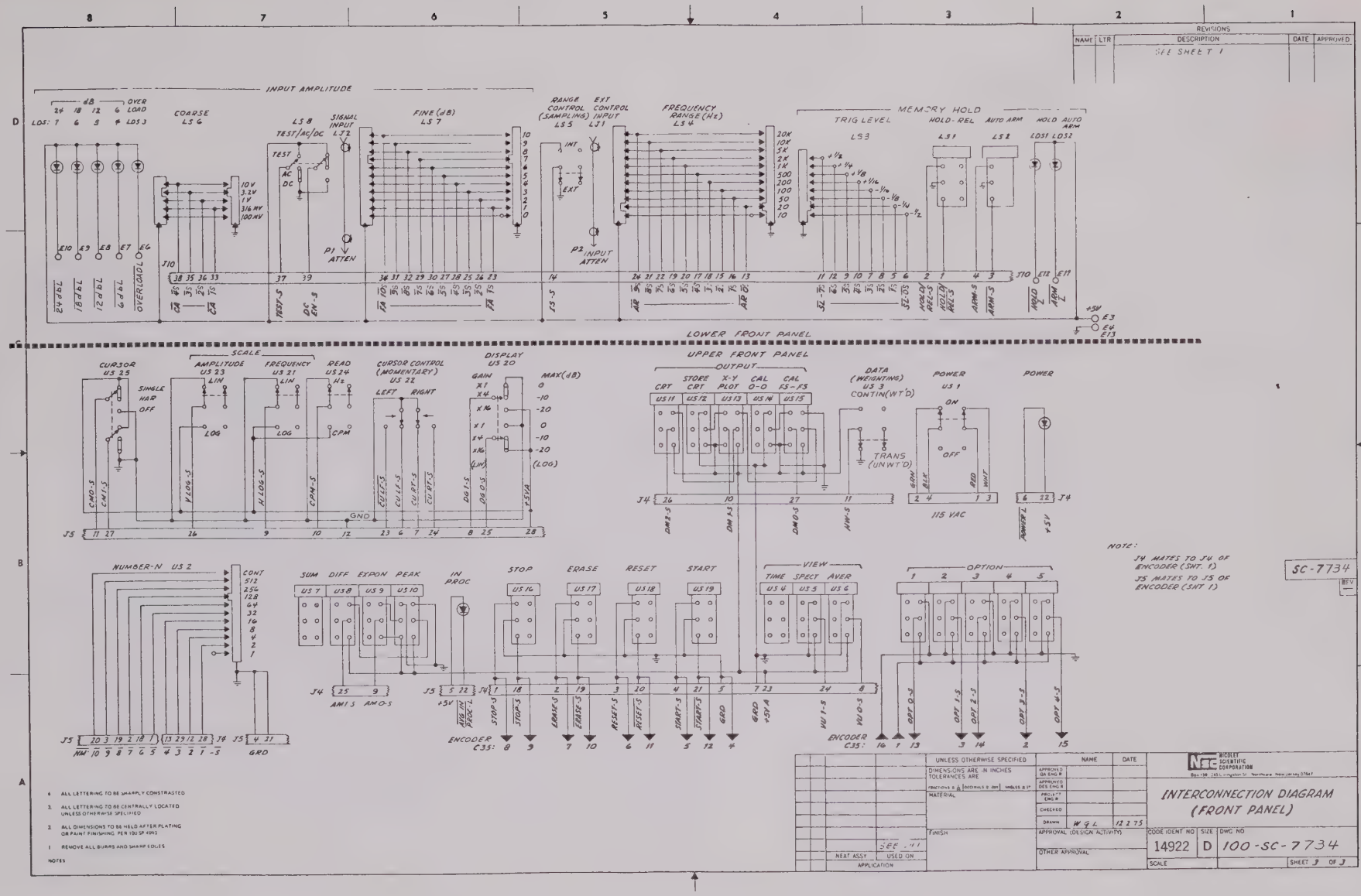
INTERCONNECTION DIAGRAM UA-440

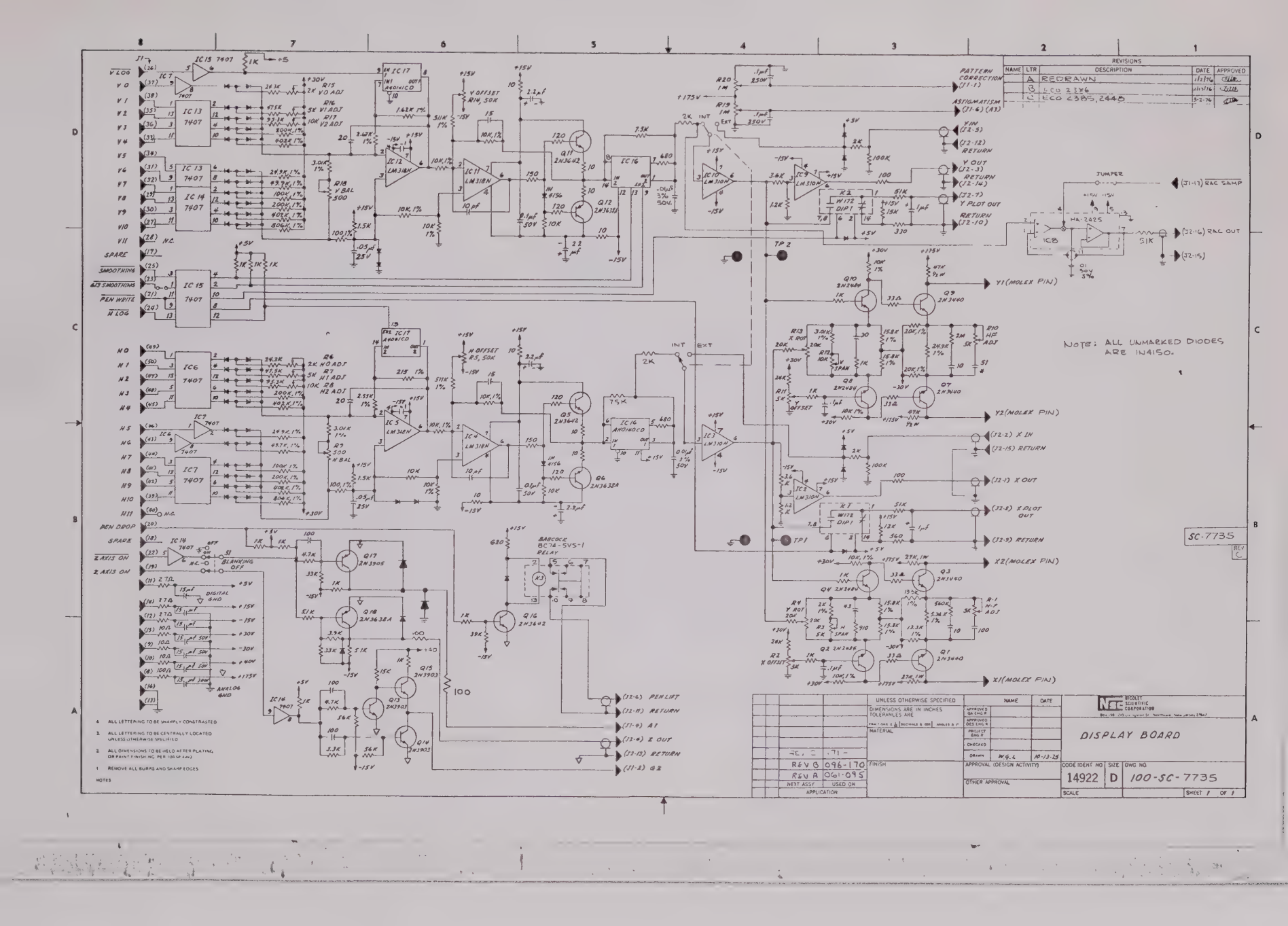
CODE IDENT NO	SIZE	DWG NO
14922	E	100-SC-7734

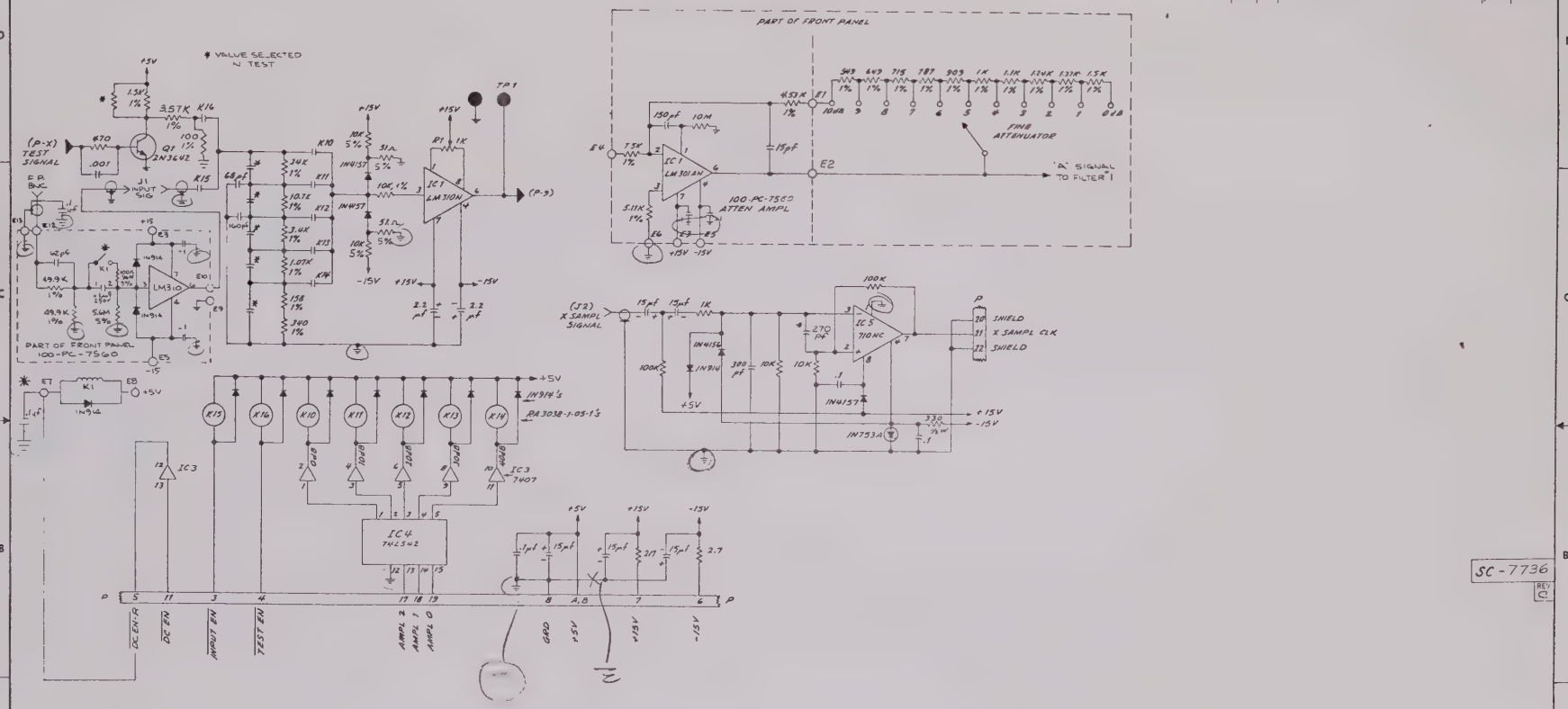
SCALE — SHEET 1 OF 3


REVISIONS
NAME | LTR | DESCRIPTION | DATE | APPROVED
SEE SHEET 1
FRONT PANEL LOWER SECTION
SIGNAL INPUT
GAIN CONTROL INPUT
INPUT ATTENUATOR J1
ATTEN AMPL
FILTERS #1 J2
FILTERS #2 J3
AVG START & TR CAPTURE J5
A/D CONV J4
SAMPLING CONTROL J6
TO/FROM SHEET 1
TO FRONT PANEL (CONT'D)
TO ENCODER (SHEET 1)
SC-7734
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
MATERIAL
FINISH
NEXT ASSY
USED ON
APPLICATION
NAME
DATE
APPROVED QA ENG
APPROVED DES ENG
PROJECT ENG
CHECKED
DRAWN MGL 12-7-75
APPROVAL (DESIGN ACTIVITY)
OTHER APPROVAL
TEKTRONIX SCIENTIFIC CORPORATION
INTERCONNECTION DIAGRAM (FRONT END)
CODE IDENT NO 14922
SIZE D
DWG NO 100-SC-7734
SCALE
SHEET 2 OF 3
NOTES
1. REMOVE ALL BURRS AND SHARP EDGES
2. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER 100 SP 1083
3. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
4. ALL LETTERING TO BE SHARPLY CONSTRASTED

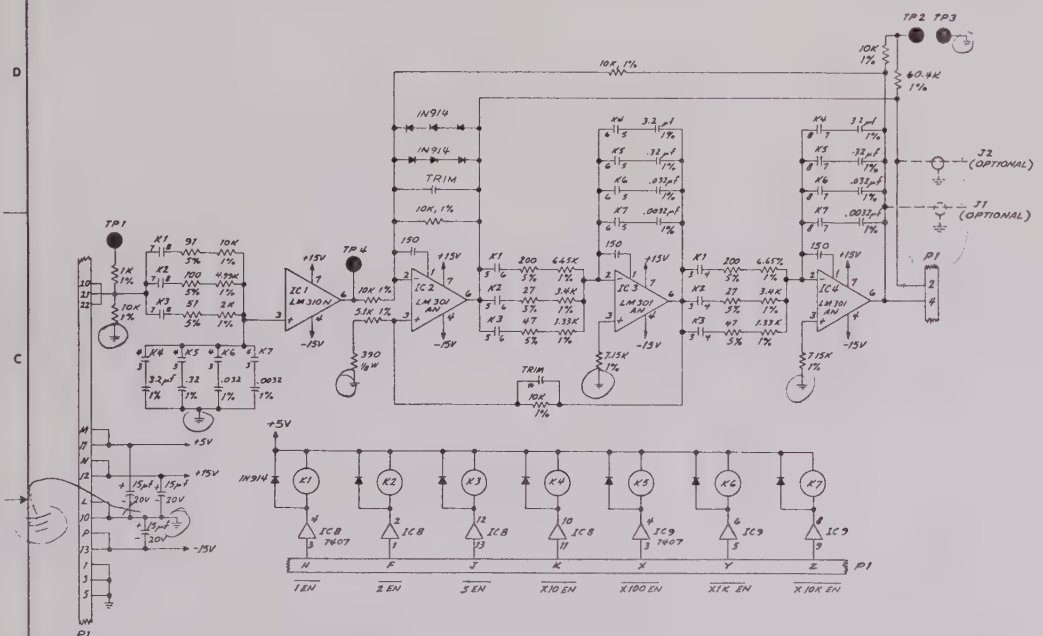

FRONT PANEL LOWER SECTION
SIGNAL INPUT
EXT. CONTROL INPUT
509 Ω 1/8 W
649 Ω 1/8 W
715 Ω 1/8 W
787 Ω 1/8 W
909 Ω 1/8 W
1K 1/8 W
1.5K 1/8 W
2.32K 1/8 W
3.57K 1/8 W
7.15K 1/8 W
+5V
SCLED's
JUMPER REMOVED WHEN OPT 263 INSTALLED
+26V
+15V
-15V
A GND
+5V
D GND
15µf 50V
15µf 20V
.01
ATTEN AMPL
SEE (100-SC-7736)
INPUT ATTENUATOR J1
ATTEN AMPL
SEE (100-SC-7736)
AVG START & TR CAPTURE J5
A/D CONV J4
FILTERS #1 J2
FILTERS #2 J3
SAMPLING CONTROL J6
24 dB
18 dB
12 dB
6 dB
OVFL
HOLD FP
ARM FF
X BUFF FULL
AVG TRIG
GATED EOC
EOC
OVFL
AD 0
AD 1
AD 2
AD 3
AD 4
AD 5
AD 6
AD 7
AD 8
AD 9
AD 10
X INT AD EN
CLK-1
X SAMPL CLK
STOP ON FULL
LEV 0
LEV 1
POS
ARM
HOLD/CONT
X BLK SYNC
X AD READY
D GND
-15V
+15V
+5V
+30V
A GND
FILTER SIG
FILT SIG 1
FILT SIG 2
1 EN
2 EN
X 100 EN
X 1K EN
X 10K EN
2 MS CLK
FR 0
FR 1
FR 2
FR 3
INPUT EN
X SAMPL EN
FR 4
AMPL 0
AMPL 1
AMPL 2
DC EN
TEST SIG
TEST EN
INPUT EN
AMPLITUDE 0
AMPL 1
AMPL 2
DC EN
Q1 LM340H24
TO/FROM SHEET 1
TO FRONT PANEL (SHT 3)
TO ENCODER (SHT U)
HOLD/DEL-S
ARM-S
SL 0-S
SL 1-S
SL 2-S
SL 3-S
SL 4-S
SL 5-S
SL 6-S
SL 7-S
AD 0-S
AR 1-S
AR 2-S
AR 3-S
AD 4-S
AR 5-S
AR 6-S
AD 7-S
AR 8-S
AR 9-S
FA 1-S
FA 2-S
FA 3-S
FA 4-S
FA 5-S
FA 6-S
FA 7-S
FA 8-S
FA 9-S
FA 10-S
CA 1-S
CA 2-S
CA 3-S
CA 4-S
TEST-S
INT X RATE
DC EN-S
OPT 141
J10
J11
263 OPT
SIGNAL OUT
SIGNAL IN
+50
GRD
-18
+18
INTERNAL SYNTH J7
10 MHz CONVERTER J8
BANDPASS FILTER DOWN CONVERTER J9
SYNTH OUT
EXT. SYNTH IN
INT TRIG
EXT TRIG
FRONT PANEL
EXPAND ON
EXT. ORIGIN FREQ. INPUT
EXT
INT
LOCKED
MSB
LSB
SC-7734
REVISIONS
NAME LTR DESCRIPTION DATE APPROVED
SEE SHEET 1
INTERCONNECTION DIAGRAM (FRONT END)
HEWLETT SCIENTIFIC CORPORATION
CODE IDENT NO 14922
SIZE D
DWG NO 100-SC-7734
SHEET 2 OF 3
SCALE
DRWN MGL 12-7-75
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
MATERIAL
FINISH
NEXT ASSY
USED ON
APPLICATION
APPROVAL (DESIGN ACTIVITY)
OTHER APPROVAL
NOTES
6 ALL LETTERING TO BE SHARPLY CONTRASTED
3 ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
2 ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER 100 SP 1003
1 REMOVE ALL BURRS AND SHARP EDGES

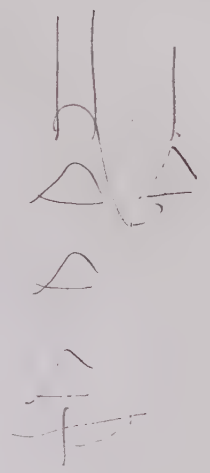

REVISIONS
NAME | LTR | DESCRIPTION | DATE | APPROVED
SEE SHEET 1
INPUT AMPLITUDE
dB
24 18 12 6 OVER LOAD
LDS: 7 6 5 4 LDS 3
COARSE LS 6
LS 8 TEST/AC/DC
SIGNAL INPUT LJ2
FINE (dB) LS 7
RANGE CONTROL (SAMPLING) LS 5
EXT CONTROL INPUT LJ1
FREQUENCY RANGE (Hz) LS 4
MEMORY HOLD
TRIG LEVEL LS 3
HOLD-REL LS 1
AUTO ARM LS 2
HOLD AUTO ARM LDS1 LDS2
P1 ATTEN
P2 INPUT ATTEN
LOWER FRONT PANEL
UPPER FRONT PANEL
CURSOR US 25
SCALE
AMPLITUDE US 23
FREQUENCY US 21
READ US 24
CURSOR CONTROL (MOMENTARY) US 22
DISPLAY US 20
OUTPUT
CRT US 11
STORE CRT US 12
X-Y PLOT US 13
CAL 0-0 US 14
CAL FS-FS US 15
DATA (WEIGHTING) US 3
POWER US 1
NUMBER-N US 2
SUM US 7
DIFF US 8
EXPON US 9
PEAK US 10
IN PROC
STOP US 16
ERASE US 17
RESET US 18
START US 19
VIEW
TIME US 4
SPECT US 3
AVER US 6
OPTION
ENCODER C35:
NOTE:
J4 MATES TO J4 OF ENCODER (SHT. 1)
J5 MATES TO J5 OF ENCODER (SHT 1)
SC-7734
NOTES
1. REMOVE ALL BURRS AND SHARP EDGES
2. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER 100 SP 4003
3. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
4. ALL LETTERING TO BE SHARPLY CONSTRASTED
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
MATERIAL
FINISH
NEXT ASSY
USED ON
APPLICATION
NAME
DATE
APPROVED QA ENG R
APPROVED DES ENG R
PROJ ENG R
CHECKED
DRAWN W G L 12 2 75
APPROVAL (DESIGN ACTIVITY)
OTHER APPROVAL
NEC NICOLET SCIENTIFIC CORPORATION
INTERCONNECTION DIAGRAM (FRONT PANEL)
CODE IDENT NO 14922
SIZE D
DWG NO 100-SC-7734
SCALE
SHEET 3 OF 3


REVISIONS
NAME | LTR | DESCRIPTION | DATE | APPROVED
A REDRAWN
B ECO 2336
C ECO 2385, 2448
DISPLAY BOARD
SC-7735
NOTE: ALL UNMARKED DIODES ARE 1N4150.
14922 D 100-SC-7735
SHEET 1 OF 1


REVISIONS
NAME | LTR | DESCRIPTION | DATE | APPROVED
A RELEASED 1/13/76
B ECO 2450-2451 2-3-76
C RELEASED FOR SN 171- 3-5-76
PART OF FRONT PANEL
100-PC-7500 ATTEN AMPL
FINE ATTENUATOR
'A' SIGNAL TO FILTER
VALUE SELECTED IN TEST
(P-X) TEST SIGNAL
(P-Y)
(J2) X SAMPL SIGNAL
SHIELD
X SAMPL CLK
SHIELD
PART OF FRONT PANEL 100-PC-7560
IC1 LM301AN
IC3 7407
IC4 74LS42
IC5 710HC
RA3038-1-05-1's
1N914's
DCEN-A
DCEN
MUXEN
TEST EN
AMPL 2
AMPL 1
AMPL 0
GND
+5V
+15V
-15V
NOTES
1. REMOVE ALL BURRS AND SHARP EDGES
2. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER MIL-STD-1183
3. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
4. ALL LETTERING TO BE SHARPLY CONSTRASTED
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
MATERIAL
FINISH
NEXT ASSY | USED ON
APPLICATION
NAME | DATE
DRAWN W. G. L. 11-23-75
CHECKED
ENG APPROVAL
PROJECT ENG
APPROVED QA ENG
APPROVED DESIGN
APPROVAL (DESIGN ACTIVITY)
OTHER APPROVAL
NICOLET SCIENTIFIC CORPORATION
INPUT ATTENUATOR
CODE IDENT NO 14922
SIZE D
DWG NO 100-SC-7736
SCALE
SHEET 1 OF 1
SC-7736
REV C

REVISIONS				
NAME	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED	1-1-74	
RB	B	ECO 1330	8-12-74	
	C	RELEASED FOR SN 171-	3-5-76	





SC-7737
REV C

NOTES

1. REMOVE ALL BURRS AND SHARP EDGES
2. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER 100SP-1063
3. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
4. ALL LETTERING TO BE SHARPLY CONTRASTED

REV C	171-		
REV B	096-170	FINISH	
REV A	061-095		
NEXT ASSY	USED ON		
APPLICATION			

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± .DECIMALS ± ANGLES ±
MATERIAL

	NAME	DATE
APPROVED QA ENG R		
APPROVED DES ENG R		
PROJECT LNG R		
CHECKED		
DRAWN	W G L	11-10-75
APPROVAL (DESIGN ACTIVITY)		
OTHER APPROVAL		

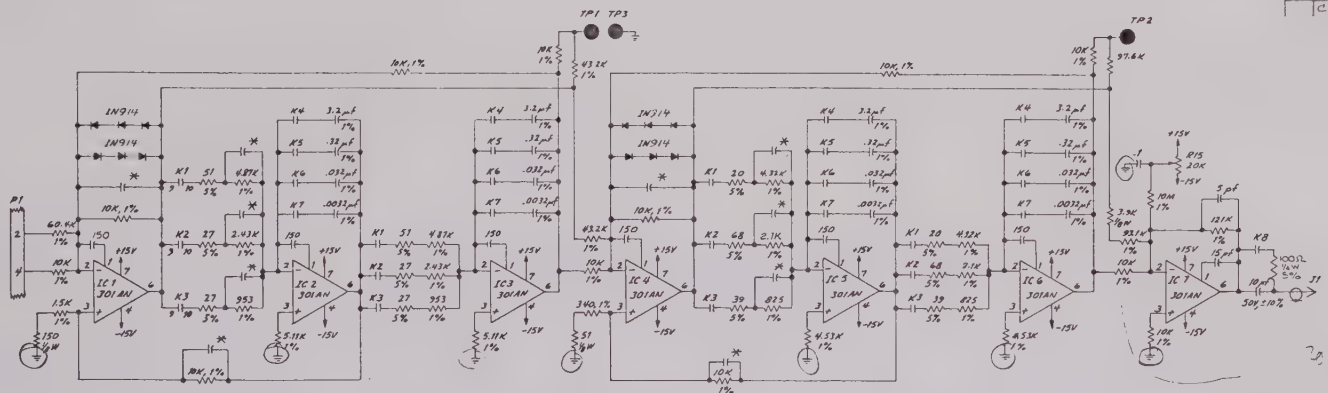
ASTRONICS CORPORATION
Box 158 - 263 Langston St - Hartsburg, New Jersey 07647

FILTER NO. 1

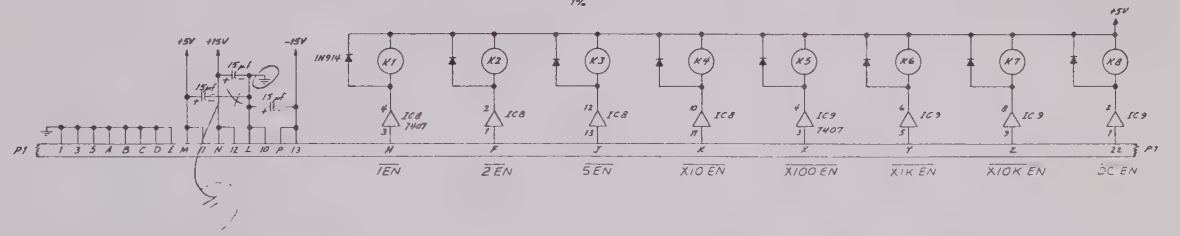
CODE IDENT NO	SIZE	DWG NO
14922	D	100-SC-7737

SCALE
SHEET 1 OF 1

REVISIONS				
NAME	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED	1/2/76	
KB	B	ECO 2330	2-12-76	
	C	RELEASED FOR S/N 171-	3-5-76	



* SELECTED IN TEST

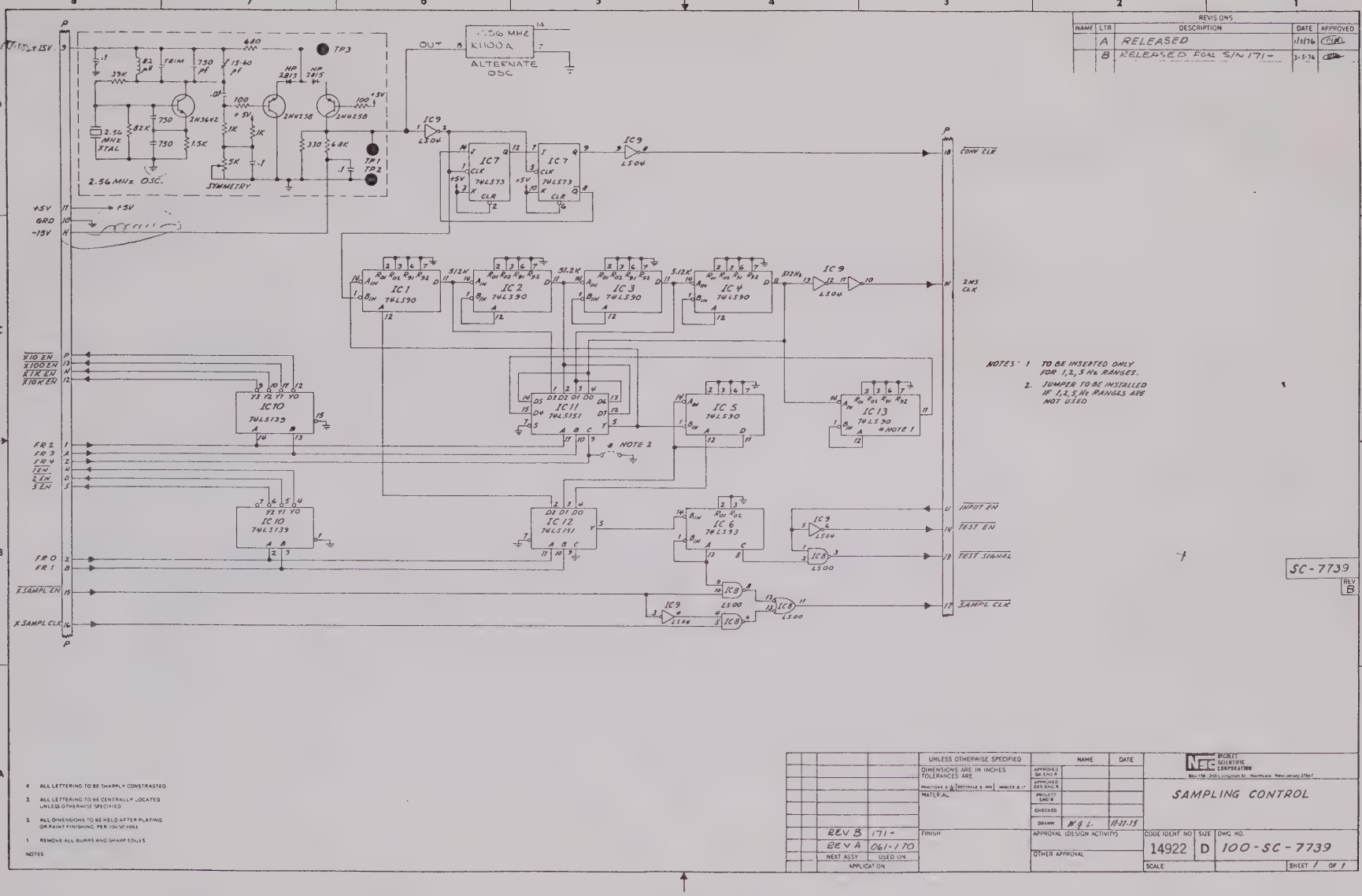


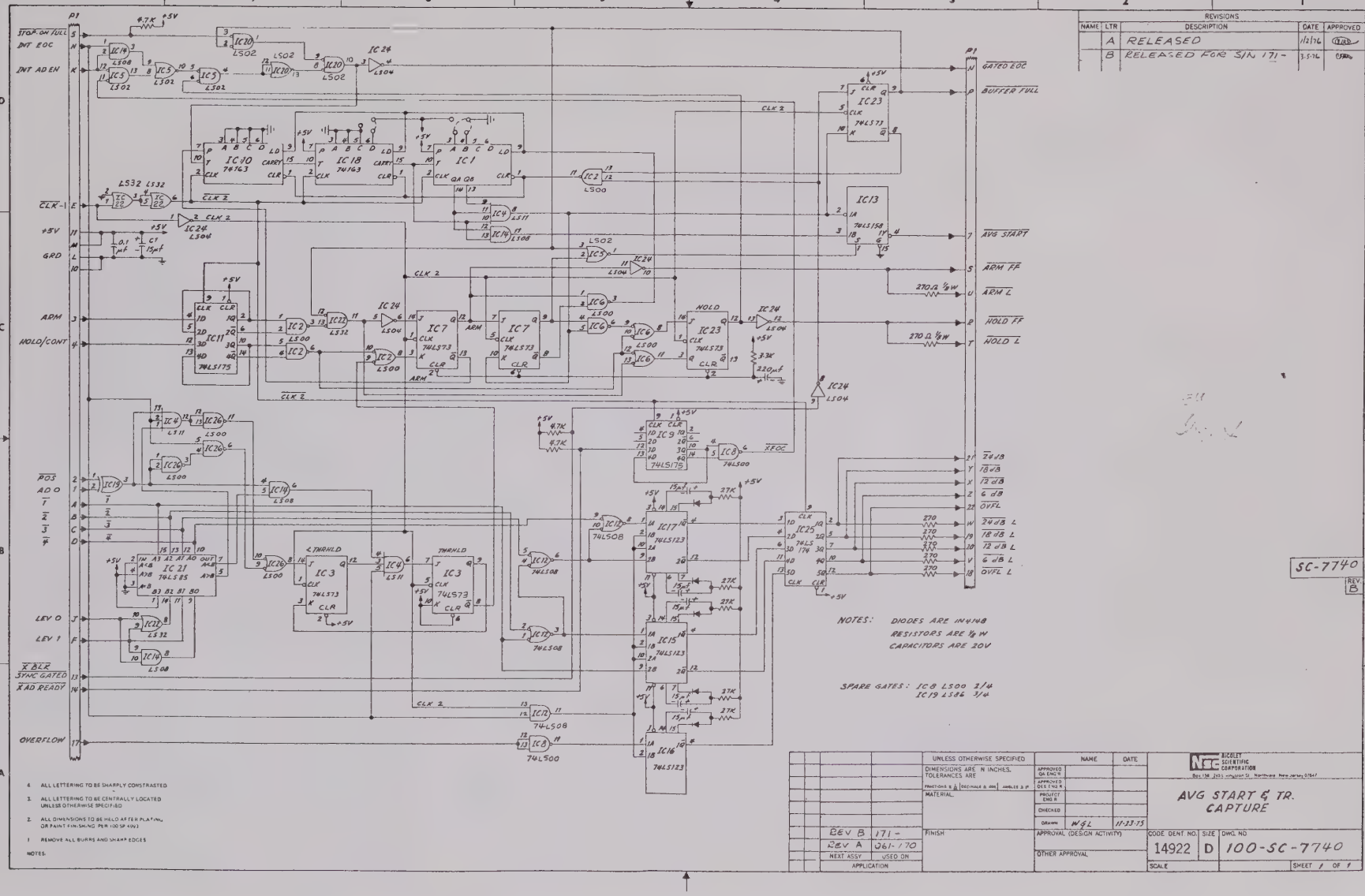
SC-7738
REV C

NOTES

4. ALL LETTERING TO BE SHARPLY CONTRASTED
3. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
2. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER MIL-STD-1463
1. REMOVE ALL BURRS AND SHARP EDGES

UNLESS OTHERWISE SPECIFIED		NAME	DATE	NSC NICOLET SCIENTIFIC CORPORATION
DIMENSIONS ARE IN INCHES TOLERANCES ARE	APPROVED QA ENG'R			
FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1°	APPROVED DES ENG'R			
MATERIAL	PROJECT ENG'R			FILTER NO. 2
	CHECKED			
REV C 171-	DRAWN	W&L	11-21-75	
REV B 096-170	APPROVAL (DESIGN ACTIVITY)			CODE IDENT NO 14922 / SIZE D / DWG NO 100-SC-7738
REV A 061-095	OTHER APPROVAL			SCALE / SHEET 1 OF 1
FINISH				
NEXT ASSY / USED ON				
APPLICATION				


REVISIONS
NAME | LTR | DESCRIPTION | DATE | APPROVED
A RELEASED 1/1/76
B RELEASED FOR S/N 171- 3-5-76
2.56 MHz OSC.
ALTERNATE OSC
11.56 MHz K1100A
SYMMETRY
2.56 MHz XTAL
IC1 74LS90
IC2 74LS90
IC3 74LS90
IC4 74LS90
IC5 74LS90
IC6 74LS93
IC7 74LS73
IC9 LS04
IC10 74LS139
IC11 74LS151
IC12 74LS151
IC13 74LS90
IC8 LS00
CONV CLK
2MS CLK
INPUT EN
TEST EN
TEST SIGNAL
SAMPL CLK
NOTES: 1. TO BE INSERTED ONLY FOR 1,2,5 Hz RANGES.
2. JUMPER TO BE INSTALLED IF 1,2,5 Hz RANGES ARE NOT USED
NOTES
1. ALL LETTERING TO BE SHARPLY CONSTRASTED
2. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
3. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER MIL-STD-
4. REMOVE ALL BURRS AND SHARP EDGES
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
MATERIAL
FINISH
NAME DATE
APPROVED
CHECKED
DRAWN R. S. L. 11-11-75
APPROVAL (DESIGN ACTIVITY)
OTHER APPROVAL
REV B 171-
REV A 061-170
NEXT ASSY USED ON
APPLICATION
ECKELT SCIENTIFIC CORPORATION
SAMPLING CONTROL
CODE IDENT NO 14922
SIZE D
DWG NO. 100-SC-7739
SCALE
SHEET 1 OF 1
SC-7739
REV B



REVISIONS				
NAME	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED	1/2/76	
	B	RELEASED FOR S/N 171-	3-5-76	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONS ± | DECIMALS ± | ANGLES ±
MATERIAL
FINISH
NEXT ASSY | USED ON
APPLICATION

	NAME	DATE
APPROVED QA ENG'R		
APPROVED DES'NG'R		
PROJECT ENG'R		
CHECKED		
DRAWN	W&L	11-13-75
APPROVAL (DESIGN ACTIVITY)		
OTHER APPROVAL		

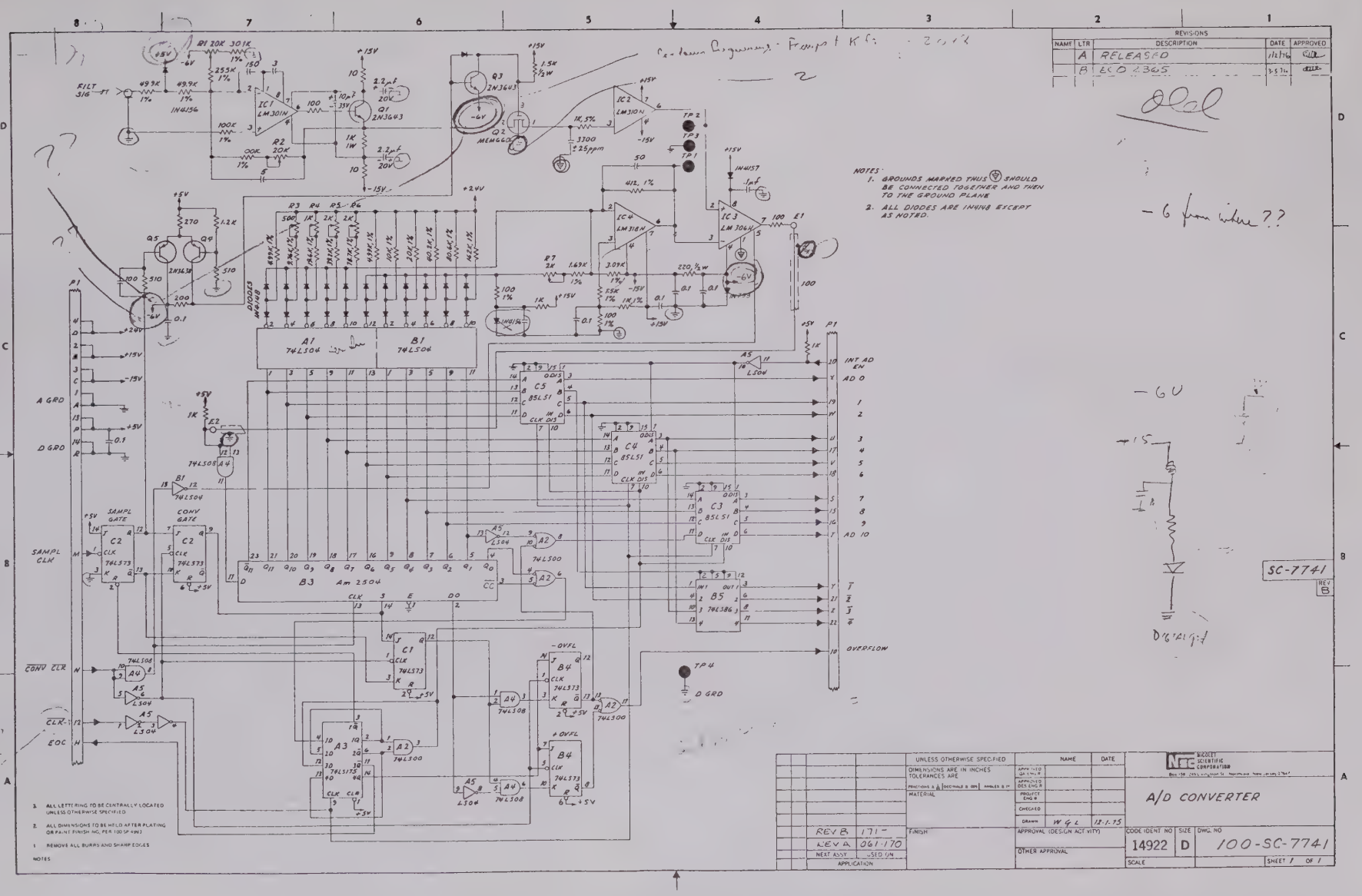
REV B 171-
REV A 061-170

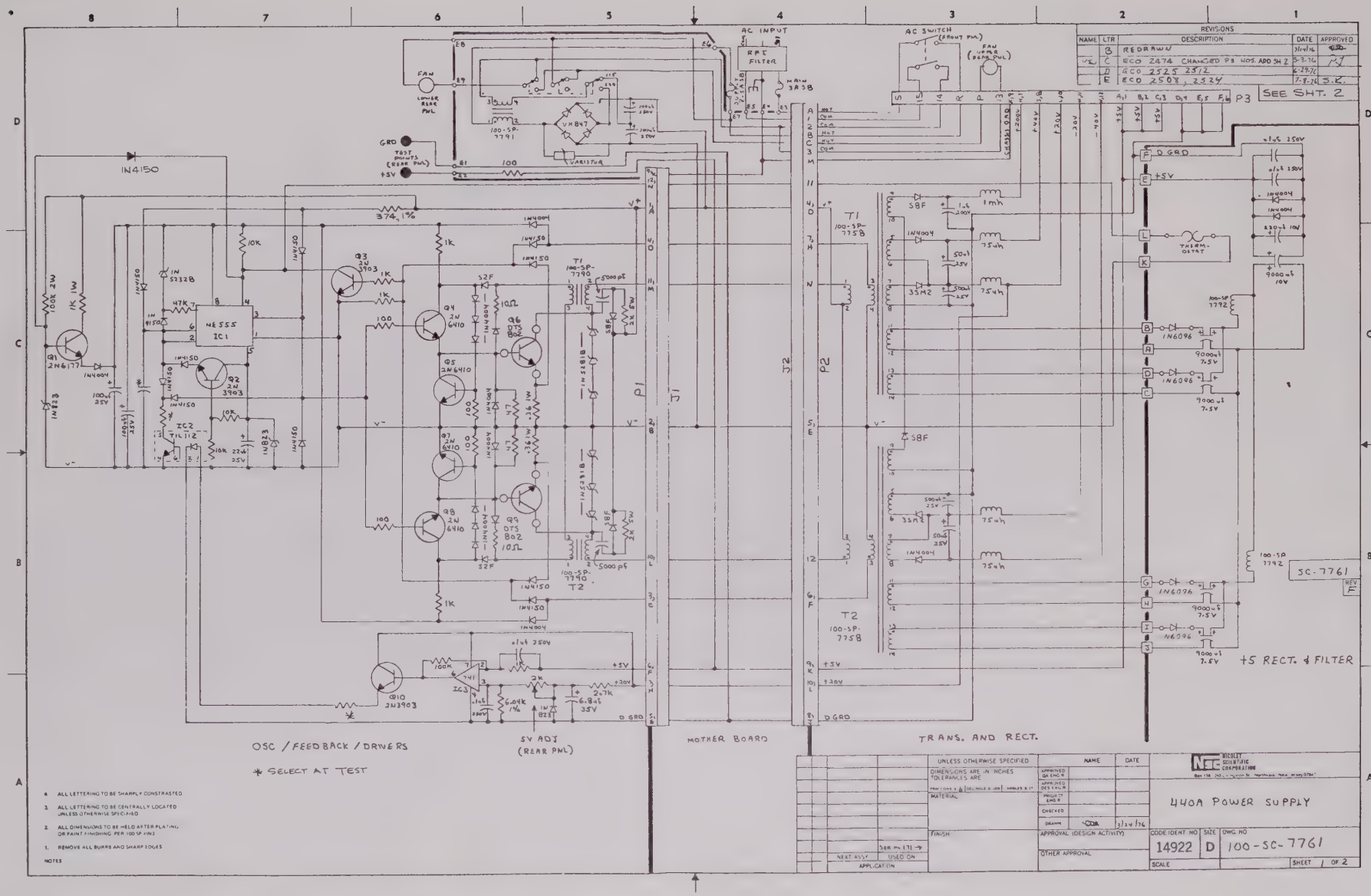
BIGELEY SCIENTIFIC CORPORATION
Box 138 241 Hamilton St Northvale New Jersey 07647

AVG START & TR. CAPTURE

CODE IDENT NO.	SIZE	DWG NO
14922	D	100-SC-7740

SCALE
SHEET 1 OF 1


REVISIONS
NAME | LTR | DESCRIPTION | DATE | APPROVED
A RELEASED 11-12-74
B ECO 2365 3-5-75
NOTES:
1. GROUNDS MARKED THUS ⏚ SHOULD BE CONNECTED TOGETHER AND THEN TO THE GROUND PLANE
2. ALL DIODES ARE IN4148 EXCEPT AS NOTED.
A1 74LS04
B1 74LS04
B3 Am 2504
C1 74LS73
C2 74LS73
C3 85LS51
C4 85LS51
C5 85LS51
B5 74LS86
A2 74LS00
A3 74LS175
A4 74LS08
A5 LS04
IC1 LM301N
IC2 LM310N
IC3 LM304H
IC4 LM318N
Q1 2N3643
Q2 MEM604
Q3 2N3643
Q4 2N3638
Q5 2N3638
SAMPL GATE
CONV GATE
SAMPL CLK
CONV CLR
CLR-1
EOC
A GRD
D GRD
INT AD EN
AD 0
AD 10
OVERFLOW
-OVFL
+OVFL
TP4
D GRD
-6V
+15V
-15V
+5V
+24V
SC-7741
REV B
Detail
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
MATERIAL
FINISH
NAME DATE
DRAWN W G L 12-1-75
CHECKED
PROJECT ENG'R
APPROVED DES ENG'R
APPROVED QUALITY CONTROL
APPROVAL (DESIGN ACTIVITY)
OTHER APPROVAL
BIOMED SCIENTIFIC CORPORATION
A/D CONVERTER
CODE IDENT NO 14922
SIZE D
DWG NO 100-SC-7741
SCALE
SHEET 1 OF 1
REV B 171-
REV A 061-170
NEXT ASSY USED ON
APPLICATION
3. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
2. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING, PER 100-SP-M01
1. REMOVE ALL BURRS AND SHARP EDGES
NOTES



REVISIONS				
NAME	LTR	DESCRIPTION	DATE	APPROVED
	B	REDRAWN	11/14/74	
VK	C	ECO 2474 CHANGED P3 NOS. ADD SH 2	5-3-76	PJ
	D	ECO 2525 2512	6-29-76	
	E	ECO 2508, 2524	7-8-76	S.K.

NOTES

4. ALL LETTERING TO BE SHARPLY CONSTRASTED
3. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
2. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER 100-SP-4143
1. REMOVE ALL BURRS AND SHARP EDGES

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONS ± DECIMALS ± ANGLES ±
MATERIAL
FINISH
NEXT ASSY | USED ON | APPLICATION

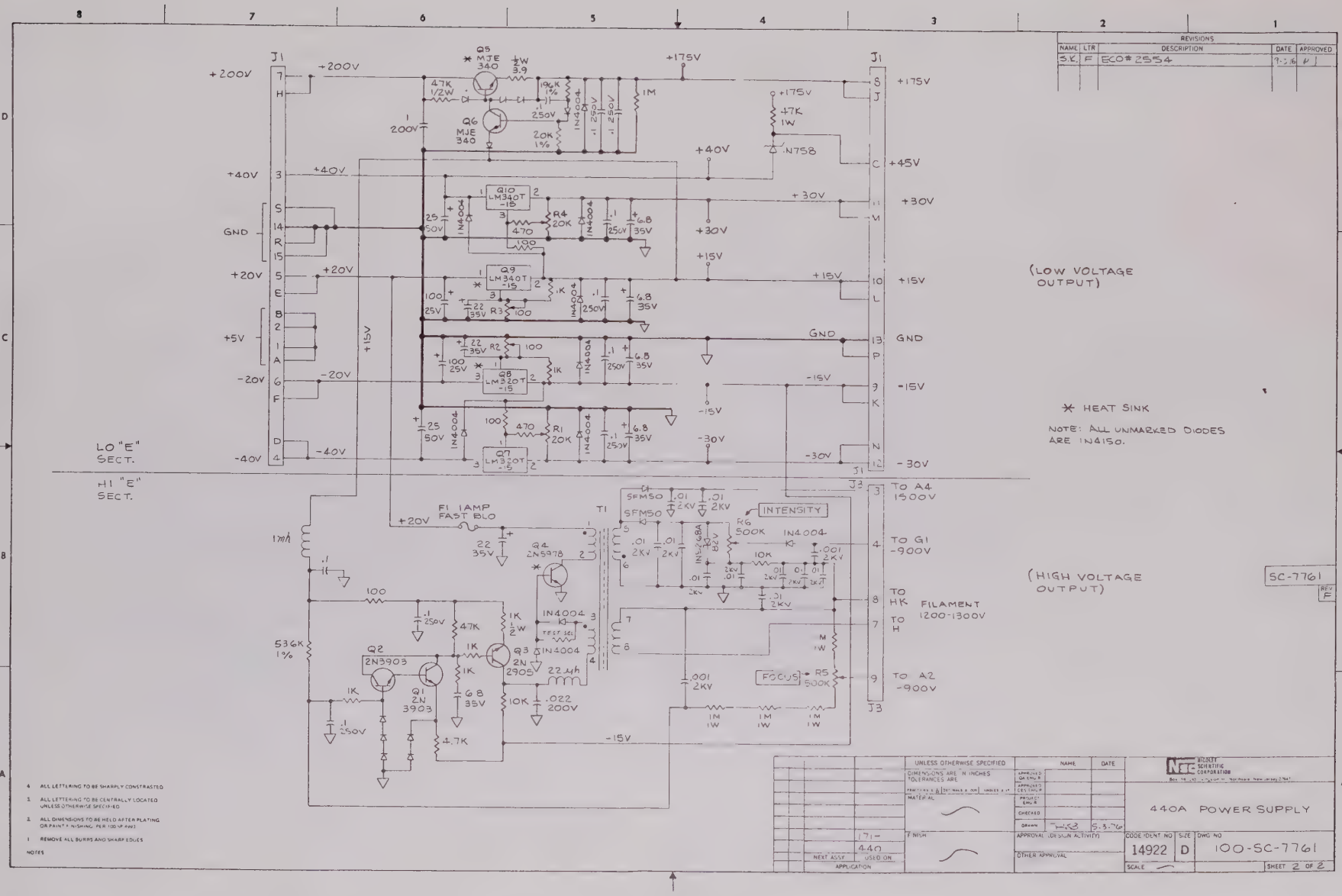
	NAME	DATE
APPROVED QA ENG'R		
APPROVED DES ENG'R		
PROJECT ENG'R		
CHECKED		
DRAWN	CDA	3/24/76
APPROVAL (DESIGN ACTIVITY)		
OTHER APPROVAL		

NEC BIDDLEY SCIENTIFIC CORPORATION

440A POWER SUPPLY

CODE IDENT NO	SIZE	DWG. NO
14922	D	100-SC-7761

SCALE | SHEET 1 OF 2



REVISIONS				
NAME	LTR	DESCRIPTION	DATE	APPROVED
S.K.	F	ECO# 2554	9-3-76	

SC-7761 REV F

4 ALL LETTERING TO BE SHARPLY CONSTRASTED
3 ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
2 ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING, PER 100 VP 4001
1 REMOVE ALL BURRS AND SHARP EDGES
NOTES

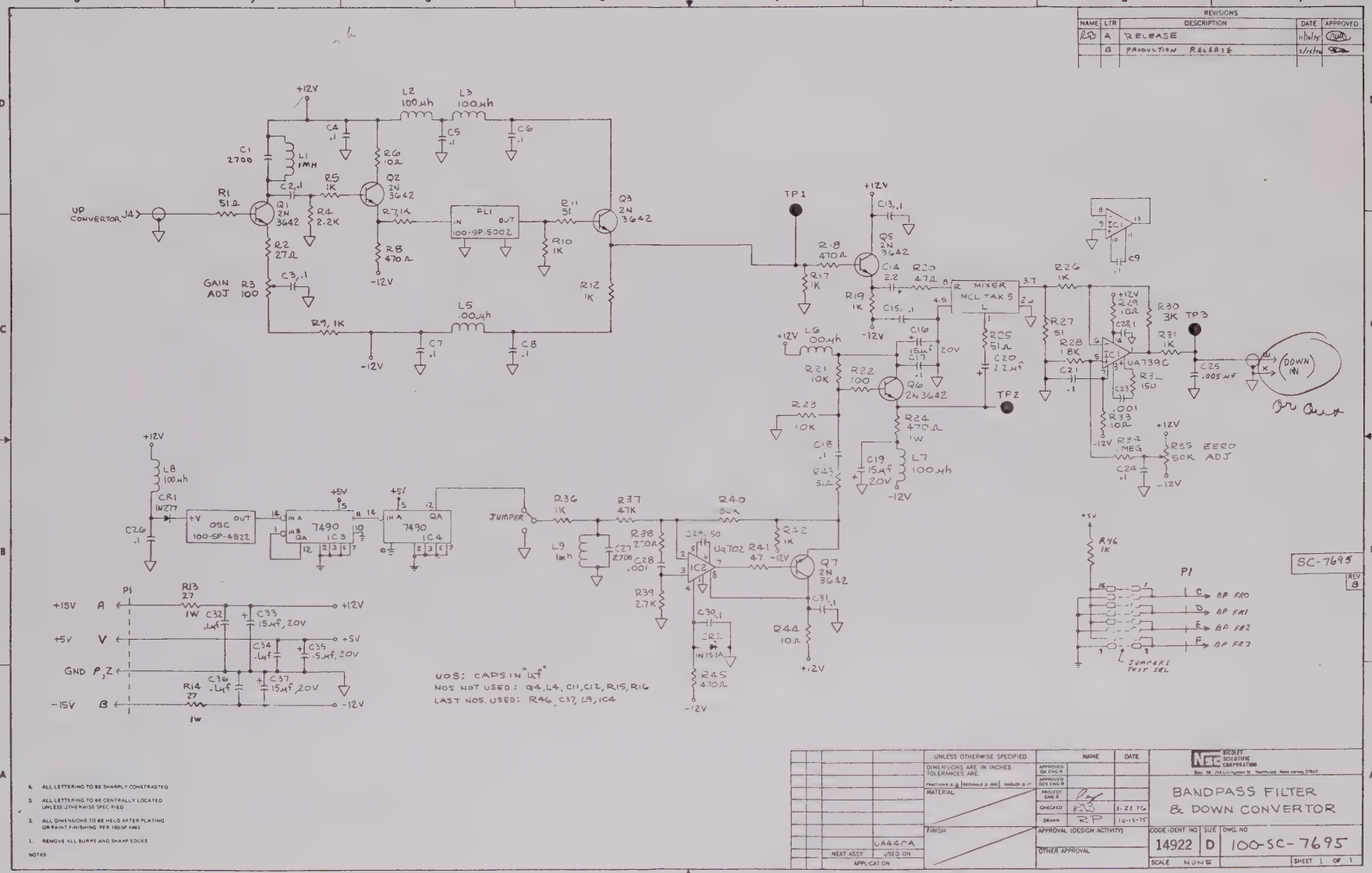
UNLESS OTHERWISE SPECIFIED	NAME	DATE
DIMENSIONS ARE IN INCHES TOLERANCES ARE		
MATERIAL		
FINISH		
DRAWN	[illegible]	5.3.76
CHECKED		
PROJECT ENGR		
APPROVED QA ENGR		
APPROVED CUSTOMER		
APPROVAL (DESIGN ACTIVITY)		
OTHER APPROVAL		
NEXT ASSY	USED ON	
171- 440		
APPLICATION		

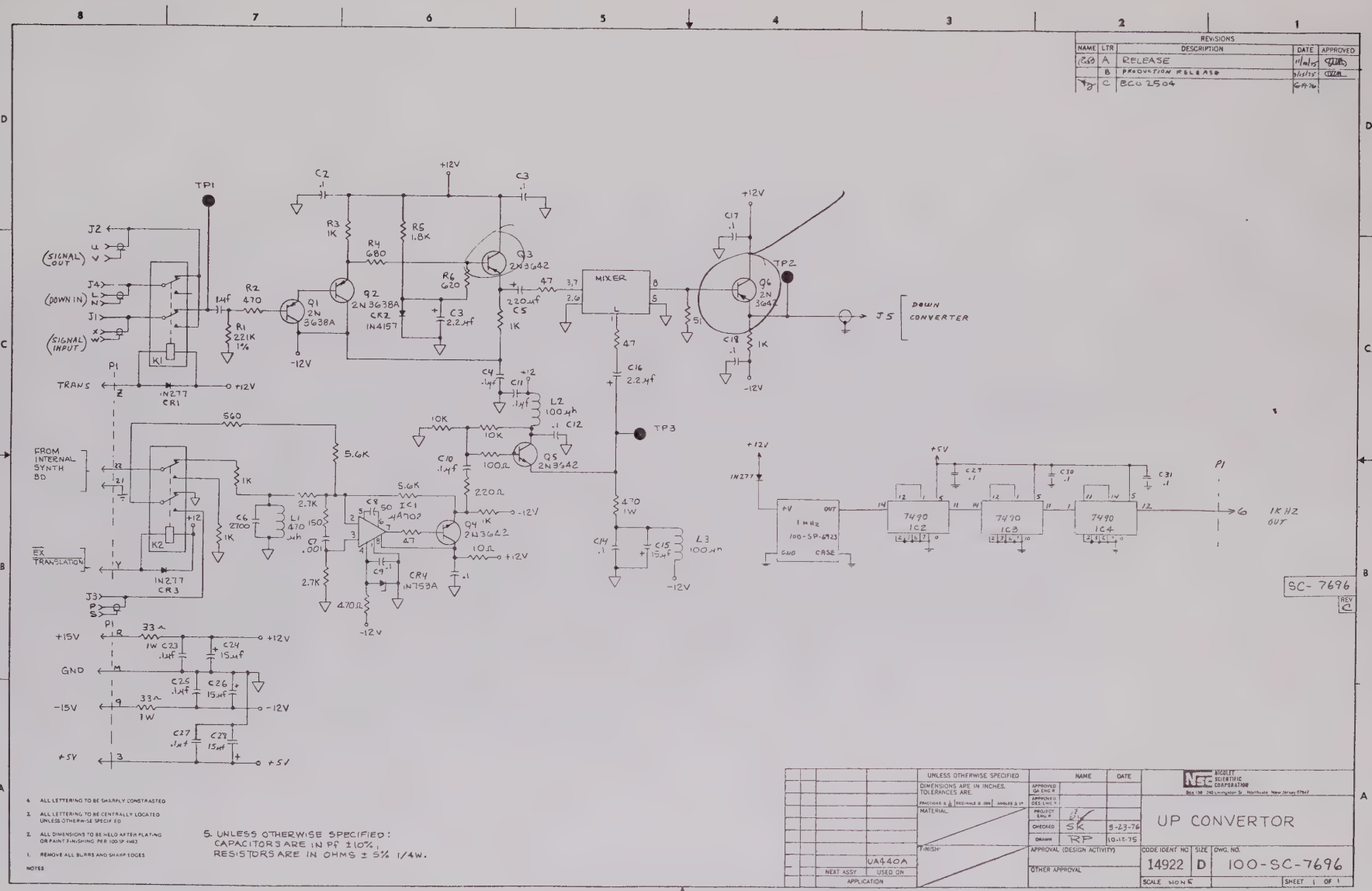
NEC NUCLEAR ENTERPRISES CORPORATION

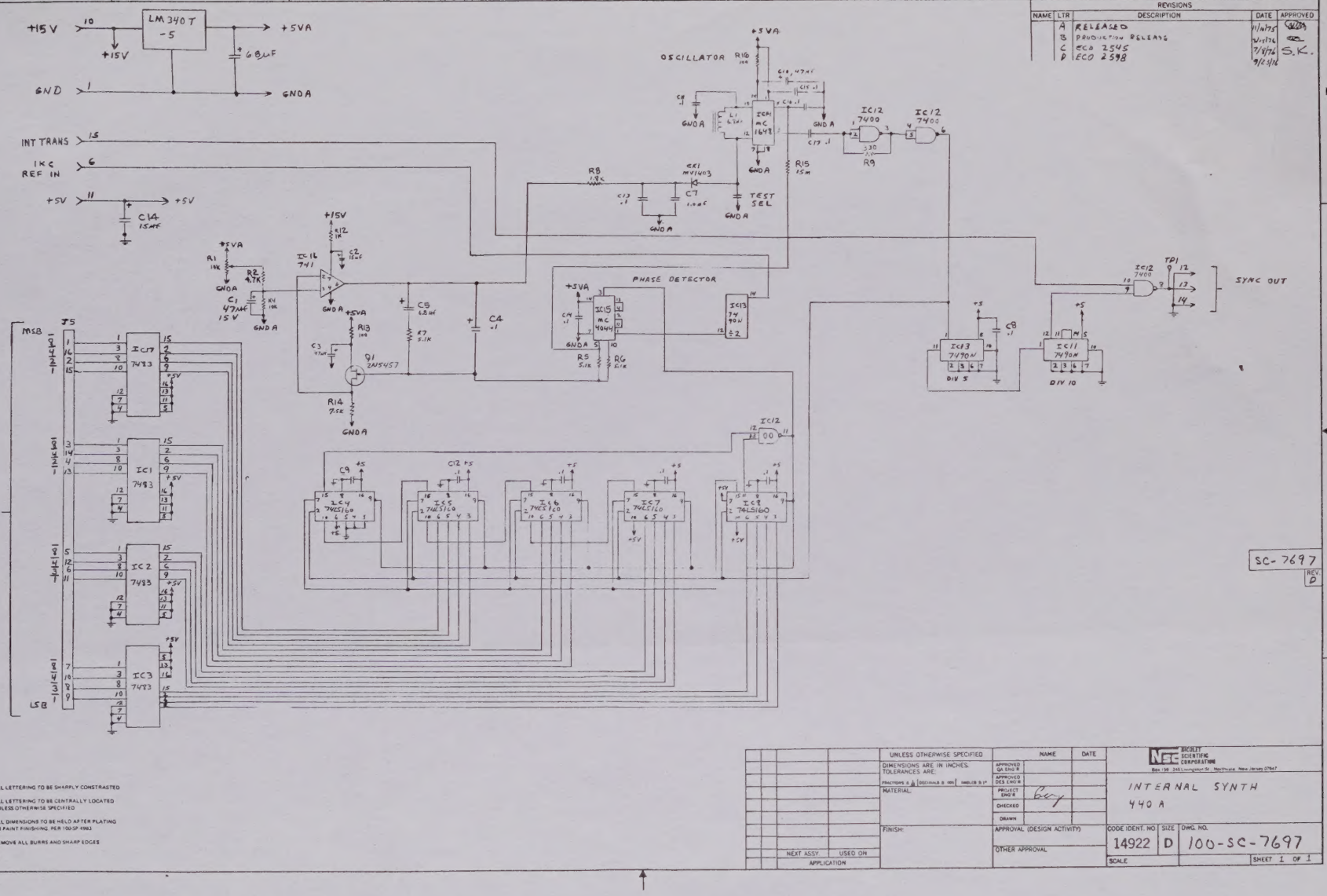
440A POWER SUPPLY

CODE IDENT NO	SIZE	DWG NO
14922	D	100-SC-7761

SCALE — SHEET 2 OF 2


REVISIONS
NAME | LTR | DESCRIPTION | DATE | APPROVED
RSD | A | RELEASE | 11/8/75
B | PRODUCTION RELEASE | 3/15/76
+12V
L2 100µh
L3 100µh
C1 2700
L1 1MH
C2 .1
C4 .1
C5 .1
C6 .1
R6 10Ω
R5 1K
Q2 2N 3642
R7 1K
FL1 100-SP-5002
R11 51
Q3 2N 3642
R10 1K
R8 470Ω
-12V
R12 1K
UP CONVERTOR J4
R1 51Ω
Q1 2N 3642
R4 2.2K
R2 27Ω
GAIN ADJ R3 100
C3 .1
R9 1K
L5 .00µh
C7 .1
C8 .1
TP1
R18 470Ω
R17 1K
Q5 2N 3642
C14 2.2
R19 1K
C15 .1
R20 47Ω
MIXER MCL TAK 5 L
C16 15µf 20V
C17 .1
L6 00µh
R21 10K
R22 100
Q6 2N 3642
R23 10K
C18 .1
R24 470Ω 1W
C19 15µf 20V
L7 100µh
R25 51Ω
C20 22µf
TP2
R26 1K
R27 51
R28 1.8K
C21 .1
IC1 UA739C
C22 .1
C23 .001
R33 10Ω
R29 10Ω
R30 3K
R31 1K
TP3
C25 .005µf
DOWN IN
R32 .1 MEG
R35 ZERO 50K ADJ
C24 .1
L8 100µh
CR1 IN277
C26 .1
OSC 100-SP-4822
7490 IC3
7490 IC4
JUMPER
R36 1K
R37 47K
R40 50K
L9 1mh
C27 2700
C28 .001
C29 50
UA702 IC2
R41 47
R42 1K
Q7 2N 3642
R39 2.7K
C30 .1
CR2 IN753A
R45 470Ω
C31 .1
R44 10Ω
R46 1K
P1
BP FR0
BP FR1
BP FR2
BP FR3
JUMPERS TEST SEL
P1
R13 27 1W
+15V A
+5V V
GND P,Z
-15V B
C32 .1µf
C33 15µf, 20V
C34 .1µf
C35 15µf, 20V
C36 .1µf
C37 15µf, 20V
R14 27 1W
UOS: CAPS IN "Uf"
NOS NOT USED: Q4, L4, C11, C12, R15, R16
LAST NOS. USED: R46, C37, L9, IC4
SC-7695
REV B
NOTES
4. ALL LETTERING TO BE SHARPLY CONSTRASTED
3. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
2. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER 100-SP-M03
1. REMOVE ALL BURRS AND SHARP EDGES
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
MATERIAL
FINISH
NEXT ASSY | USED ON
APPLICATION
NAME | DATE
APPROVED QA ENG R
APPROVED DES ENG R
PROJECT ENG R
CHECKED RJS 3-22-76
DRAWN RP 10-15-75
APPROVAL (DESIGN ACTIVITY)
OTHER APPROVAL
BRADLEY SCIENTIFIC CORPORATION
BANDPASS FILTER & DOWN CONVERTOR
CODE IDENT NO 14922 | SIZE D | DWG NO 100-SC-7695
SCALE NONE | SHEET 1 OF 1


REVISIONS
NAME | LTR | DESCRIPTION | DATE | APPROVED
A RELEASE
B PRODUCTION RELEASE
C ECO 2504
TP1
J2
(SIGNAL OUT)
J4
(DOWN IN)
J1
(SIGNAL INPUT)
K1
P1
TRANS
IN277 CR1
+12V
R1 221K 1%
R2 470
1uf
Q1 2N 3638A
Q2 2N3638A
CR2 IN4157
-12V
C2 .1
C3 .1
R3 1K
R4 680
R5 1.8K
R6 620
Q3 2N3642
C3 2.2uf
220uf C5
1K
47
3.7
2.6
MIXER
8
5
L
S
+12V
C17 .1
TP2
Q6 2N 3642
C18 .1
1K
-12V
J5
DOWN CONVERTER
C4 .1uf
C11 .1uf
L2 100uh
.1 C12
10K
10K
TP3
C10 .1uf
100Ω
Q5 2N3642
220Ω
-12V
FROM INTERNAL SYNTH BD
560
5.6K
1K
5.6K
2.7K
C6 2700
L1 470 uh
150
C7 .001
C8 50 uA702
IC1
Q4 2N3642
47
10Ω
+12V
C9 .1
CR4 IN753A
.1
2.7K
470Ω
-12V
EX TRANSLATION
K2
IN277 CR3
J3
P1
+15V
33Ω
1W C23 .1uf
C24 15uf
+12V
GND
C25 .1uf
C26 15uf
-15V
33Ω
1W
-12V
C27 .1uf
C28 15uf
+5V
+5V
C16 2.2uf
47
1W
470
C14 .1
C15 15uf
L3 100uh
-12V
+12V
IN277
+V
OUT
1 MHz
100-SP-6923
GND
CASE
+5V
C29 .1
C30 .1
C31 .1
7490 IC2
7490 IC3
7490 IC4
P1
6
1K HZ OUT
SC-7696
REV C
1. REMOVE ALL BURRS AND SHARP EDGES
2. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER 100-SP-4903
3. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
4. ALL LETTERING TO BE SHARPLY CONSTRASTED
NOTES
5. UNLESS OTHERWISE SPECIFIED: CAPACITORS ARE IN Pf ±10%; RESISTORS ARE IN OHMS ± 5% 1/4W.
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
MATERIAL
FINISH
NEXT ASSY
USED ON
UA440A
APPLICATION
NAME
DATE
APPROVED QA ENG'R
APPROVED DES ENG'R
PROJECT ENG'R
CHECKED SK 5-23-76
DRAWN RP 10-12-75
APPROVAL (DESIGN ACTIVITY)
OTHER APPROVAL
NGE NIGGLEY SCIENTIFIC CORPORATION
UP CONVERTOR
CODE IDENT NO 14922
SIZE D
DWG. NO. 100-SC-7696
SCALE NONE
SHEET 1 OF 1



REVISIONS				
NAME	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED	11/14/75	
	B	PRODUCTION RELEASE	4/1/76	
	C	ECO 2545	7/8/76	S.K.
	D	ECO 2598	9/23/76	

SC-7697 REV. D

4. ALL LETTERING TO BE SHARPLY CONSTRASTED
3. ALL LETTERING TO BE CENTRALLY LOCATED UNLESS OTHERWISE SPECIFIED
2. ALL DIMENSIONS TO BE HELD AFTER PLATING OR PAINT FINISHING PER 100-SP-1983
1. REMOVE ALL BURRS AND SHARP EDGES

NOTES:

UNLESS OTHERWISE SPECIFIED		NAME	DATE	NSC SCIENTIFIC COMPONENTS Box 150 245 Livingston St Northvale New Jersey 07647	
DIMENSIONS ARE IN INCHES. TOLERANCES ARE:	APPROVED QA ENG'R				
FRACTIONS ±	DECIMALS .X ±	.XXX ± .5°	APPROVED DES ENG'R		
MATERIAL:	PROJECT ENG'R	Bey		INTERNAL SYNTH 440 A	
	CHECKED				
	DRAWN				
FINISH:	APPROVAL (DESIGN ACTIVITY)			CODE IDENT. NO. 14922	SIZE D
NEXT ASSY.	USED ON	OTHER APPROVAL		DWG. NO. 100-SC-7697	
APPLICATION				SCALE	SHEET 1 OF 1

MP MASTER
MA35655